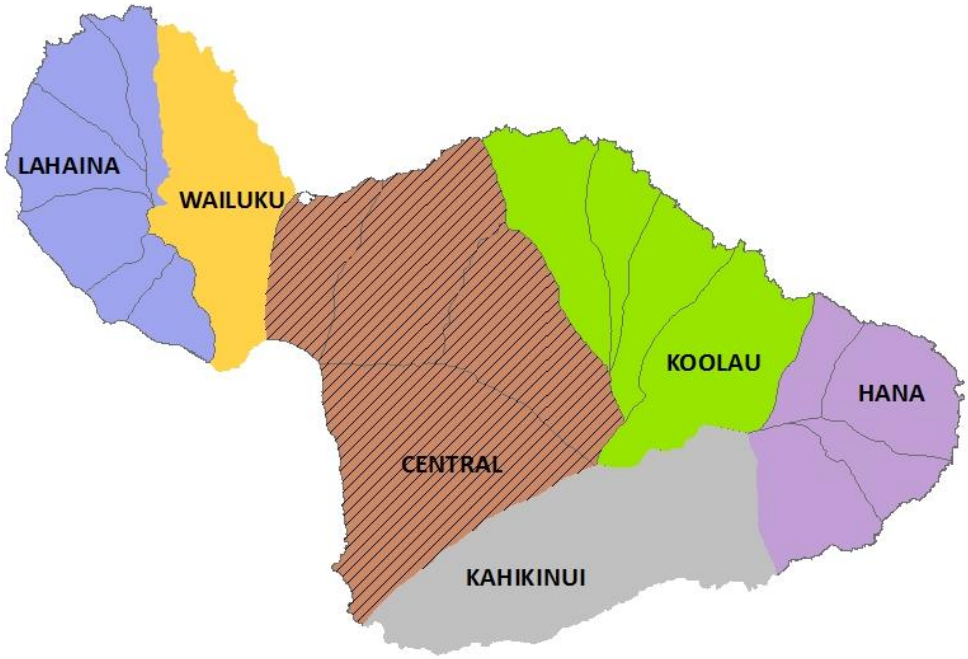


MAUI ISLAND WATER USE AND DEVELOPMENT PLAN DRAFT

PART III REGIONAL PLANS

CENTRAL AQUIFER SECTOR AREA

Table of Contents

CENTRAL AQUIFER SECTOR AREA

The Central Aquifer Sector Area (ASEA) encompasses about 229.33 square miles, including 4 groundwater aquifer system areas (ASEAs) underlying the western flank of Haleakalā Mountain: Kahului, Pa`ia, Makawao, and Kama`ole. The population of the Central Aquifer Sector Area includes parts of the resident populations from the following community plan areas: Kīhei-Mākena, Wailuku-Kahului, Makawao-Pukalani-Kula, Pā`ia-Ha`ikū, and to a very minor extent Hana. The estimated population of the Central ASEA was 103,970 in 2015 and is projected to increase by approximately 33 percent to 138,164 by 2035.

The Central Aquifer Sector Area (ASEA) remains the economic and population center of the island. In the 1990s, this area saw significant increases in trade, transportation, communications and utilities, and government jobs. Kahului is the island's major commercial-industrial and shipping center and has the largest employment center. The Central ASEA comprises about 50% of the Wailuku-Kahului Community Plan District. The district has the largest resident population of all community regions. Kahului's residential neighborhoods are separated from commercial uses. The 2030 Socio-Economic Forecast suggests the Wailuku-Kahului Community Plan Area will grow faster than other parts of Maui, as former sugar lands are developed into residential subdivisions. Wailuku-Kahului is expected to maintain its status as home to more than a third of Maui's households.

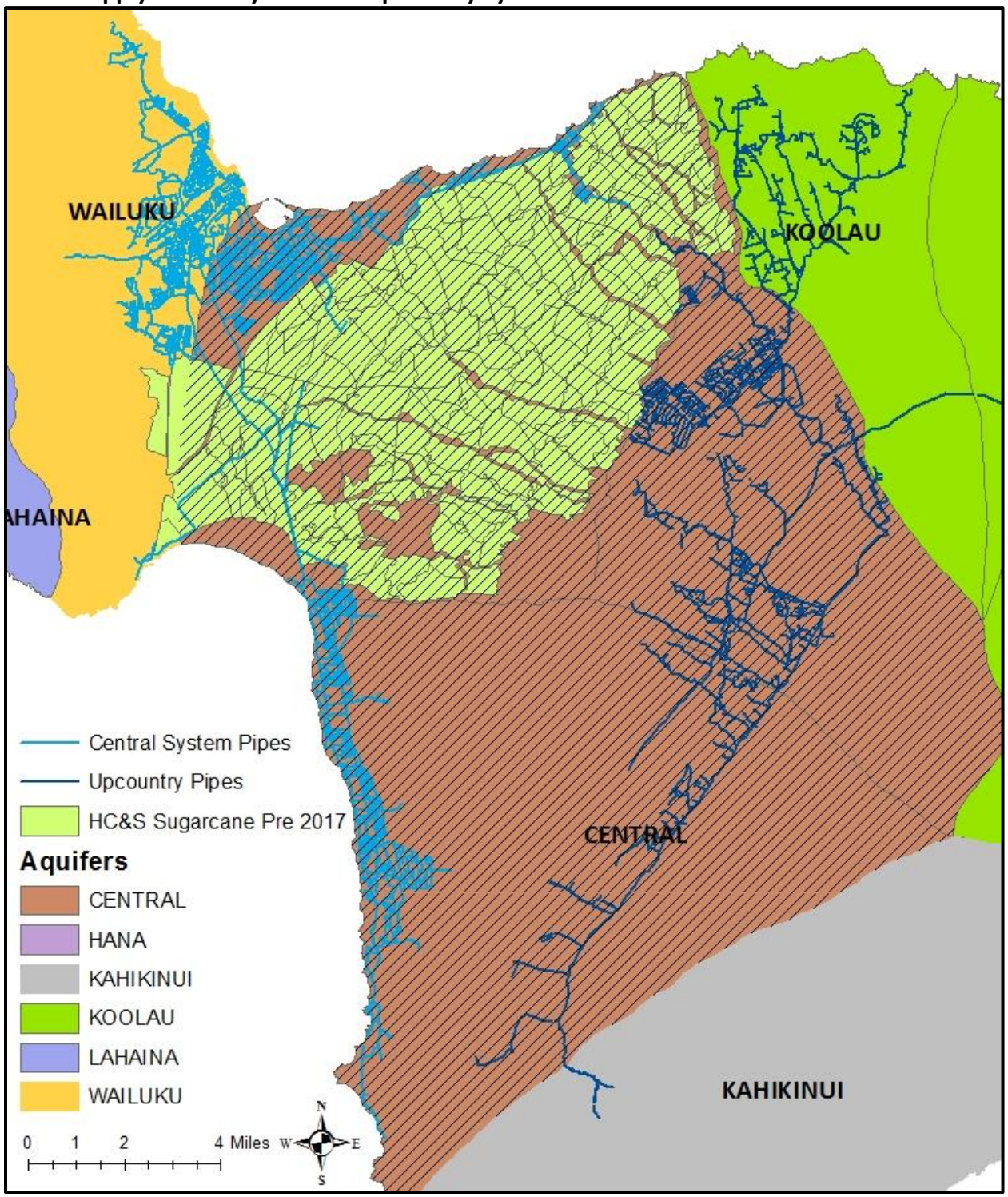
The WUDP uses aquifer sector hydrologic units for presentation and analysis consistent with state requirements for updating the plan. The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries than aquifer sectors. The majority of the Central ASEA lies within the moku of Kula, with portions of the Central isthmus also encompassing the moku of Pu`ali Komohana and Hamakuapoko, and to a minor extent the moku of Hamakualoa. The southernmost portion of the ASEA is encompassed by the moku of Honua`ula.

The roughly 37,000 acre Hawaii Commercial and Sugar (HC&S) plantation overlies the Central ASEA. Lands cultivated in sugarcane through 2016 are undergoing a transition to diversified agriculture. Agricultural irrigation supply on the Central isthmus comes from a combination of surface water from East Maui Streams in the Ko`olau ASEA, surface water from Na Wai Eha in the Wailuku ASEA, and groundwater within the Central ASEA.

Public water supply used in the Central ASEA is also primarily generated from outside the aquifer sector. Two of the Maui Department of Water Supply (MDWS) systems are partially located in the Central ASEA: The Central Maui System (Central System) services the north shore from Waihe`e to Paia/Kuau, Kahului, Wailuku, Waikapu and the south shore from Ma`alaea to Makena. The Upcountry System services the Haiku, Makawao, Pukalani and Kula communities.

The figure below shows the MDWS systems and HC&S lands overlying the three aquifer sectors.

Figure 15-1 Wailuku, Central and Ko`olau Aquifer Sectors, HC&S Lands, Maui Department of Water Supply Central System and Upcountry System



15.1 PLANNING FRAMEWORK

15.1.1 Key Issues

Issues Raised in the Water Use and Development Plan Public Process

Initial efforts to update the 1990 WUDP included a public process and stakeholder meetings in 2007 – 2009 that addressed the MDWS Upcountry system but not all water uses and users in the Central ASEA. The Upcountry Water Advisory Committee identified a broad range of planning objectives and suggested candidate strategies for this MDWS system.

The WUDP update was reignited at the end of 2015 and MDWS staff subsequently held several rounds of open public meetings, workshops and focus meetings for various stakeholder and special interest groups during 2016 that identified key issues and concerns for each region. In addition to input at meetings, the Department conducted manual and on-line surveys to poll residents on water issues and solutions for their regions. Because the overlap between the MDWS water systems and hydrologic boundaries can be confusing, meetings held in Upcountry focused both on the resources within the Central and Ko`olau aquifer sectors and the MDWS Upcountry system, while meetings held in Central Maui focused on the Wailuku aquifer sector and the MDWS Central System. Many of the issues raised pertain to stream diversions from the Ko`olau ASEA that are ultimately transported to Central and Upcountry Maui. While overlapping, key issues identified for the Central ASEA, which includes Central, South and Upcountry Maui communities and water resources within the Ko`olau ASEA relate to managing the development and transportation of water from areas with abundant rainfall to areas with scarce rainfall and subsidizing infrastructure in water scarce areas, maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Much of the public water use in the Central ASEA relies on Ko`olau surface water resources conveyed via privately owned transmission systems. A key issue for the region is providing affordable water for future needs, providing for Upcountry and central Maui isthmus farming and other public trust uses during droughts, and managing resources in a sustainable way.

Key issues and concerns can be categorized within the following interests:

- Water Management and Transport
- Streamflow Protection and Native Hawaiian Rights and Uses
- Department of Hawaiian Homelands Needs
- Impact of HC&S transition
- Environmental Protection
- Alternative Water Sources and Conservation
- Water Availability and the Upcountry Priority List

Water Management and Transport

- Transport of water primarily from the Ko`olau ASEA to Upcountry, Central, and South Maui is an issue for all of the affected communities.
- Understanding of the concepts of "precautionary planning" to reduce and adapt to the effects of drought and climate change upon water resource availability and quality is important.
- The cost of managing the East Maui Irrigation System is necessary information to evaluate future management responsibilities

Streamflow Protection and Native Hawaiian Rights and Uses

- Access to lands for gathering, hunting and other native Hawaiian traditional and customary practices.
- Consultation and coordination with Native Hawaiian community/moku and local experts on resource management and invasive species removal should be prioritized.

Water Availability and the Upcountry Priority List

- Adequate water supply to support Upcountry agriculture is a community value.
- The Community Plan says if water is available the priority is agriculture and DHHL

Alternative Water Sources and Conservation

- Adapting future populations to local water resource conditions, integrating conservation and the use of alternative resources

Environmental Protection

- Watershed protection and its prioritization is important, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Build up what is taken from aquifers

Department of Hawaiian Homelands Needs

- Water needs of DHHL should be considered in general and in accordance with the 2017 State Water Projects Plan.

Impact of HC&S transition

- Long term plans to manage the EMI system, including use and maintenance of reservoirs are a concern
- EMI system efficiency

Maui Island Plan Issues

The Maui Island Plan (MIP), adopted in 2012 identified challenges and opportunities for the MDWS systems. Issues generally apply island wide, but some are specific to the Central ASEA, the MDWS Upcountry system and users:

- Reliance on surface water Upcountry makes the system vulnerable to drought conditions
- Voluntary and mandatory water use restrictions imposed on residential and agricultural users during droughts often negatively impact the productivity of farmers
- The expense of treating (filtering and chlorinating) municipal water is not necessarily needed for agricultural users that rely on the MDWS Upcountry system
- Uncertainty over long term source to support large scale agriculture in Central Maui
- Competition for unused diverted water and uncertainty has the potential for negatively affecting future agriculture due to lending institutions' requirements to demonstrate long-term access to water to secure loans
- Potential to increase use of reclaimed water for agricultural operations and more cost effective desalination and improved technologies

Community Plan Issues

This section describes key issues identified in the Paia-Haiku Community Plan, the Makawao-Pukalani-Kula Community Plan and the Wailuku-Kahului Community Plan as it relates to regional and inter-regional water resources and use.

- The development of new ground water sources in Ha`ikū to service the Central Maui area of Wailuku-Kahului and Kihei-Makena raises a concern over the allocation of water resources to these other regions if and when the present and future needs of the Pa`ia-Ha`ikū area are not met.[1]
- A primary concern for Makawao-Pukalani-Kula residents is the limited development of water resources and a distribution system to meet the needs of the region. The proper allocation of water resources is considered essential to, in order of priority: (1) preserve agriculture as the region's principal economic activity, promote diversified agricultural activities, and effectively encourage the development of Department of Hawaiian Home Lands (DHHL) parcels; and (2) ensure the long-term viability of the region's residential and economic base.[2]

Water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[3]

[1] County of Maui, Pā`ia-Ha`ikū Community Plan, 1994, page 11
[2] County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12
[3] Ibid, page 15.

15.1.2 Plans, Goals, Objectives and Policies

The planning objectives identified by the Upcountry Water Advisory Committee through 2009 consider water service availability, reliability, quality, cost, protection of streams, water resources, cultural resources, sustainability, equity, viability, and conformance with general and community plans. [4] These are consistent with the broad planning objectives synthesized in the WUDP update public process.

The MIP island-goals, objectives and policies that apply island wide are summarized in Chapter 14.1.2. All goals and objectives adopted in Chapter 6.3 of the MIP are consistent with the broad planning objectives of the WUDP as shown in the matrix of WUDP Part I, Appendix 2 *"County Plan Policy and Programs Relevant to the WUDP, and Consistency with the Planning Objectives".*

The Central ASEA contains areas that fall under three different Community Plans: (1) the 2002 Kahului-Wailuku Community Plan; (2) the 1996 Makawao-Pukalani-Kula Community Plan; and 3) the 1995 Pā`ia-Ha`ikū Community Plan. Region and inter-regional goals, objectives and policies for the three community plans are summarized below.

<u>The 2002 Kahului-Wailuku Community Plan</u>

The Wailuku-Kahului Community Plan adopted in 2002 remains in effect. Relevant goals, objectives and policies related to water resources and water infrastructure are summarized below.

Water Resources

- Protect water resources in the region from contamination, including protecting ground water recharge areas, and wellhead protection areas within a 1.25-mile radius from the wells.
- Protect cultural and archaeological sites: `Iao Stream, taro lo`i terraces in `Iao Valley, Nā Wai `Ehā.
- Promote and implement programs for ground water and wellhead protection.

Water Availability and Use

- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Improve the quality of potable water.

[4] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District, Final Candidate Strategies Report, Upcountry Water Advisory Committee Review Draft, July 27, 2009 page 12

- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public
- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.
- Preserve agricultural lands as a major element of the open space setting bordering various communities.
  Preserve and protect native Hawaiian rights and practices customarily and traditionally exercised for subsistence, cultural and religious purposes.
- Encourage traditional Hawaiian agriculture, such as taro cultivation, within the agricultural district, in areas which have been historically associated with this cultural practices.

Supply Augmentation/Demand Controls

- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewable energy.
- Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.

<u>The 1996 Makawao-Pukalani-Kula Community Plan</u>

Water Availability and Use

- Prioritize the allocation of water as new resources and system improvements become available as follows: (a) for maintenance and expansion of diversified agricultural pursuits and for the Department of Hawaiian Home Lands projects; and then (b) for other uses including development of new housing, commercial and public/quasi-public uses.
- Encourage a flexible and comprehensive water management approach that recognizes the various collection and delivery improvements as one cohesive system.
- The Department of Water Supply shall expand water supply and distribution systems, including catchment systems, in accordance with the directions set forth in the Makawao-Pukalani-Kula Community Plan.
- Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use.
- Recognize and support the immediate allocation of water resources for Department of Hawaiian Home Lands projects and agriculture.
- Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region.
- Support the development of separate domestic and irrigation water systems. Encourage the construction of additional storage capacity by the Department of Water Supply, commercial developers, and individual farmers to help alleviate the inadequate water supply.

- Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner.

Supply Augmentation/Demand Controls

- Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents.
- Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area.
- Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.

The section that addresses DHHL needs notes that water use in the Upcountry region is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy must be developed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions. [5]

<u>The 1995 Paia-Haiku Community Plan</u>

Water Resources

- Ensure that the development of new water sources does not adversely affect in-stream flows.

Water Availability and Use

- Increase water storage capacity with a reserve for drought periods.
- Ensure that adequate water capacity is available for domestic and agricultural needs of the region. Continue the conversion to drip irrigation in sugar cane fields, provided that the practice complies with soil conservation standards.
- Improve the existing potable water distribution system and develop new potable water sources prior to further expansion of the State Urban District boundary or major subdivision of land in the State Agricultural or Rural Districts.
- Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island.

<u>The 1998 Kihei-Makena Community Plan</u>

An important overall goal of the Kīhei-Mākena Community Plan is to not allow development for which infrastructure may not be available concurrent with the development's impacts.

[5] County of Maui Makawao-Pukalani-Kula Community Plan, 1996, page 15

Water Availability and Use

- Provide for appropriate water source and transmission improvements concurrent with planned growth of the Kīhei-Mākena region.
- Support and expand the projected development of the Central Maui and East Maui water systems in order to meet the needs of all Maui residents.

Supply Augmentation/Demand Controls

- Develop water conservation, reuse and educational programs.
- Encourage the use of non-potable water for irrigation purposes and water features.
- Prohibit the use of potable water in large water features or require substantial mitigation fees.
- Encourage the use of plants which have a relatively low need for water.

15.2 Physical Setting

15.2.1 Climate and Geology

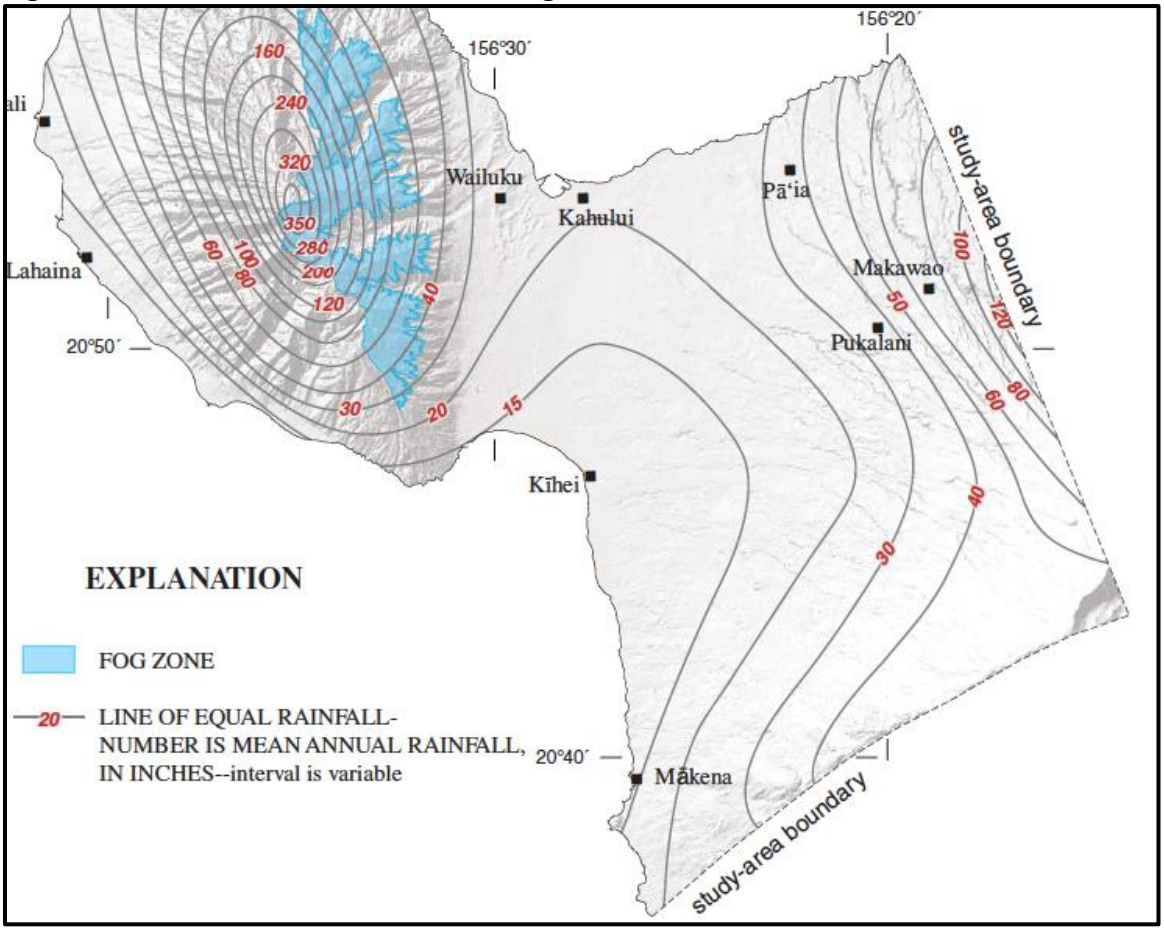
Climate

The Central Aquifer Sector includes a vast range of micro-climates. The eastern boundary is the Maliko Gulch from sea level to the summit of the Haleakala volcano. The western boundary is the foot hills of Mauna Kahalawai, or West Maui Mountains and the south shore from Maalaea to Makena. Rainfall distribution on the northern flank of Haleakalā is primarily controlled by the orographic effect. Precipitation is heaviest where the prevailing northeasterly trade winds encounter the flank of the volcano, forcing moist air to higher altitudes. The topography of Maui and the location of the north Pacific anticyclone relative to the island affect its climate, which is characterized by mild and uniform temperatures, seasonal variation in rainfall, and great geographic variation in rainfall. [6] At higher altitudes, precipitation is a combination of rainfall and fog drip where the montane forest canopy intercepts cloud water. Giambelluca and Nullet (1991) defined the fog zone on the leeward slopes of Haleakalā as extending from altitudes of about 3,900 to 5,900 ft and estimated a thicker fog zone, at altitudes of 2,000 to 6,560 ft, along windward slopes. Precipitation is supplemented by an unknown amount of fog drip, which is fog and precipitation (not measured by rain gages) that is intercepted by vegetation and that subsequently drips to the ground surface.[7]

According to the Western Region Climate Center (2007), the average temperature in Wailuku, near the coast, is 75º F, whereas the average at Haleakalā summit is 47º F. During the warmer dry season (May–September), the stability of the north Pacific anticyclone produces persistent northeasterly winds, known locally as trade winds, which blow 80–95 percent of the time. During the cooler rainy season (October–April), migratory weather systems often travel past the Hawaiian Islands, resulting in less persistent trade winds that blow 50–80 percent of the time. Low-pressure systems and associated southerly winds can bring heavy rains to the island, and the dry coastal areas can receive most of their rainfall from these systems. Mean annual rainfall ranges from 16 – 20 inches at the western boundary of Upcountry to more than 240 inches on the eastern boundary.

[6] Blumenstock, D.I. and Price, S. (1967) Climate of Hawai`i. In: Climates of the States, No. 60-51, Climatography of the United States, US Department of Commerce, Washington DC.
[7] Ibid

Figure 15-2 Mean Annual Rainfall and Fog Zone in Central and West Maui



Source: USGS Groundwater Availability in the Wailuku Area, Maui, Hawaii Report 2008-5236 (modified from Giambeluca and Nullet, 1991)

Geology

The geology of Maui was described in detail by Stearns and Macdonald[8] and some of the geologic units were subsequently reclassified by Langenheim and Clague.[9] Haleakalā has three rift zones that trend in northerly, southwesterly, and easterly directions. The rocks of Haleakalā Volcano consist of the shield-stage Honomanu Basalt, which is overlain by the postshield-stage Kula Volcanics and younger Hana Volcanics.

The Kula Volcanics, which overlies the Honomanu Basalt, comprises post-shield-stage lava flows of hawaiite with some ankaramite and alkalic basalt and associated intrusive rocks and pyroclastic and sedimentary deposits. The Kula Volcanics almost completely covers the underlying Honomanu Basalt and exposures range between 2,500 ft in thickness near the

[8] Stearns, H.T., and Macdonald, G.A., 1942, Geology and ground-water resources of the island of Maui, Hawaii: Hawaii Division of Hydrography Bulletin 7

[9] Langenheim, V.A.M., and Clague, D.A., 1987, The Hawaiian- Emperor volcanic chain, part II, stratigraphic framework of volcanic rocks of the Hawaiian Islands, chap. 1 of Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, v. 1

summit to 50–200 feet in thickness near the coast. Stearns and Macdonald have found the thickness of individual lava flows averages about 20 feet near the summit and 50 feet near the periphery, but flows as much as 200 ft thick are not rare. The usual dip of the flows is about 10 degrees. The Kula Volcanics and the Hana Volcanics are the most widespread geologic units exposed at the land surface on Maui.

The central isthmus is formed by nearly flat-lying lava flows of the Honomanu Basalt, which are interbedded with consolidated and unconsolidated sedimentary deposits. Beneath the isthmus, Honomanu Basalt of Haleakalā overlies older Wailuku Basalt of West Maui Volcano with a wedge of sedimentary deposits between the two units. Stearns and Macdonald (1942) determined that sedimentary deposits throughout Maui have been divided into consolidated earthy deposits, calcareous sand dunes, and unconsolidated deposits. A sedimentary wedge beneath the Kahului area contains a westward-thickening wedge of alluvial clay, sand, and gravel that may reach 30–50 ft in thickness within the area. Overlying the alluvium and extending farther southeastward over residual clay on the lava is a buried coral reef complex, which appears to be the landward continuation of the present offshore reef. This reef material is dominantly coral mixed with coral debris and medium to fine sand. The reef complex is overlain by sand, which grades landward from coarse to fine and reaches thicknesses of 20-30 feet. The sedimentary materials are capped beneath the land areas by the windblown sand and soils of the present land surface. [10] A similar sedimentary sequence would be expected across the isthmus and report marine sediments 40 feet above sea level near the center of the isthmus in the Waikapu Shaft Test Hole (5128-01).

15.2.2 Water Resources

The Central Aquifer Sector Area (ASEA) northern boundary stretches from Kahului to Pa`ia; the southern boundary extends to Kama`ole Aquifer in Mākena. A basal lens in the Kula Volcanics and the Honomanu Basalt comprise the groundwater resource in Kama`ole Aquifer. Within about one mile of the coast and below an elevation of 500 – 1,000 feet the groundwater is brackish. Further inland it freshens. The freshwater lens is thin. Because recharge originates in low rainfall areas and discharge of the lens at the coast is unimpeded by caprock, the head of the lens is less than 3 feet below a ground elevation of about 500 feet.[11]

Groundwater moves mainly from inland recharge areas to coastal discharge areas. Eastward flowing water from the West Maui Volcano converges with westward flowing water from Haleakalā. Groundwater recharge by direct infiltration of rainfall occurs throughout the area as high level, potentially perched, water with downward migration impeded by low-permeability geologic layers and as a freshwater lens floating on underlying saltwater. High-level water discharges to springs or directly into streambeds. There are no perennial streams in the aquifer

[10] Burnham, W.L., Larson, S.P., and Cooper, H.H., Jr., 1977, Distribution of injected wastewater in the saline lava aquifer, Wailuku-Kahului wastewater treatment facility, Kahului, Maui, Hawaii: U.S. Geological Survey Open-File Report no. 77-469

[11] Brown & Caldwell, Central/South Maui Desalination Feasibility Study Final Report, 2006

sector that would exist where a stream intersects the groundwater table or where rainfall is persistent. [12]

Climate hydrology, geology and human activities affect the hydrologic cycle and the interconnected surface and ground water systems. Perennial and intermittent streams on windward Haleakalā are generally fed by abundant rainfall and groundwater discharge.[13] Stream flow has been extensively assessed in the Ko`olau ASEA, and it is relevant because it is a significant source of water imported to the Central ASEA via the East Maui Irrigation Company (EMI) aqueduct system. Most of the public water supply in the Central ASEA is from a freshwater lens in the Wailuku ASEA. The `Iao aquifer provides most of the groundwater supply and has been extensively studied. The main groundwater system in this area consists of a freshwater lens system in dike-free volcanic rocks. Sedimentary caprock with lower permeability between West Maui Volcano and Haleakalā impedes groundwater flow between Wailuku and the isthmus as well as groundwater discharge to the coast. The water table in the dike-free volcanic rocks is less than a few tens of feet above sea level. In general, the water-table altitude is lowest near the coast and increases landward at a rate of about 1 foot per mile.[14]

Groundwater and Surface Water Recharge

A water budget includes water input and output and is modeled based on best available hydrologic, geologic and land use data. Groundwater recharge replenishes aquifers and is fed mainly by precipitation and irrigation that infiltrates the ground surface and percolates beyond the root zone in the soil. Recharge is greatest in the inland mountainous regions. Dike impounded groundwater discharges to streams, representing the continuous base flow. Where the groundwater table is below the streambed, seepage from streambeds generally recharges groundwater. Fresh groundwater that does not discharge to streams or tunnels, or is not withdrawn from wells in the dike-impounded system, flows to downgradient areas in the freshwater lens system.[15]

Caprock water refers to water confined in sedimentary caprock, commonly along the shoreline, that is recharged from surface flows, local rainfall, return irrigation water, and leakage from confined basal water. It's generally limited to non-potable uses due to its saline quality.[16]

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[12] Johnson, A.G., Engott, J.A., and Bassiouni, Maoya, 2014, Spatially distributed groundwater recharge estimated using a water-budget model for the Island of Maui, Hawai'i, 1978–2007: U.S. Geological Survey Scientific Investigations Report 2014–5168, 53 p., http://dx.doi.org/10.3133/sir20145168.

[13] Gingerich, S.B., 1999a, Ground water and surface water in the Haiku area, East Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 98–4142, 38 p.13 ; Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090

[14] Gingrich, S. 2008 U.S. GEOLOGICAL SURVEY. Ground-Water Availability in the Wailuku Area, Maui, Hawai`i Scientific Investigations Report 2008-5236

[15] Ibid.

[16] CWRM Water Resources Protection Plan, 2008 p 3-11

Before the cessation of Hawaiian Commercial & Sugar Company in December of 2016, most water diverted from the streams in Na Wai Eha, in the Wailuku ASEA, was transported to the isthmus—the center of the island found between Haleakalā and Mauna Kahalawai within the Central ASEA--and used for irrigation outside the area contributing recharge to the Wailuku ASEA. The amount and location of recharge has been profoundly affected by plantation-scale sugarcane cultivation (and, to lesser degrees, pineapple and macadamia nuts) in agricultural areas. Since the early 20th century, about 100 billion gallons of surface water has been diverted each year from island streams for crop irrigation. More than half of this diverted water, about 59 billion gallons per year, originated in East Maui. Under natural conditions, most stream water would flow to the ocean. Instead, stream water diverted for irrigation is applied to the plant-soil system, creating an artificial increase in groundwater recharge of the underlying aquifer systems (Kahului and Pā`ia aquifers). The export probably caused a net decrease in recharge to the aquifers underlying diverted streams and a net increase in recharge to the Central ASEA. Since sugarcane irrigation ceased in 2016, the impact on natural and artificial recharge has not been quantified; however, in the past, the transition from ditch/furrow irrigation to drip irrigation systems has shown to significantly decrease the amount of artificial recharge.

The interaction between the Wailuku ASEA and Ko`olau ASEA "export" hydrologic units and the Central ASEA "import" hydrologic unit is important to assess the viability of sources that are impacted by natural and artificial changes in recharge. The Maui Lani wells drilled within the Kahului aquifer just eastward of the `Iao aquifer boundary are believed to be impacted by recharge from `Iao aquifer, leaching from unlined reservoirs fed by Nā Wai `Ehā surface water, as well as irrigation return recharge within the Kahului Aquifer.

Irrigation rates in the Wailuku and Central Maui regions have been steadily decreasing since the 1970s. This decrease coincided with periods of below-average rainfall, leading to substantially reduced recharge rates. Estimated recharge for Central and West Maui declined 44 percent during the period 1926 – 2004. Groundwater recharge during average climate conditions and drought conditions was estimated by the U.S Geological Survey (USGS). A drought scenario based on rainfall during the 1998–2002 period yielded a 29 percent reduction in recharge compared to average climate conditions.

Table 15-1 Central ASEA Groundwater Recharge Estimates Drought and Average Conditions

Aquifer Sector Area	2008 WRPP Average Recharge	USGS Average Recharge	USGS Drought Recharge	% Drought Recharge Reduction (USGS)
Central	59	179	134	25%

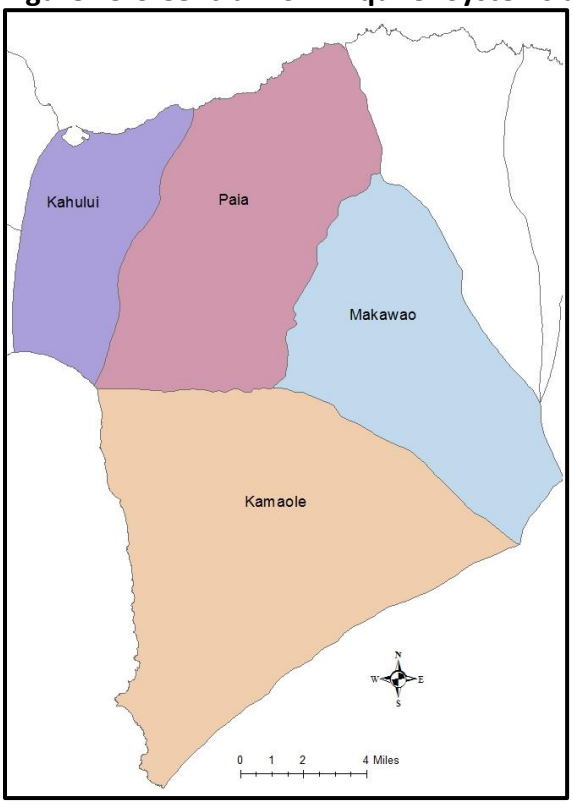
USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 2014, Table 8.

Average climate conditions are 1978–2007 rainfall and 2010 land cover. Drought conditions are 1998–2002 rainfall and 2010 land cover. WRPP- 1990, updated 2008 from CWRM where applicable, natural conditions are 1916–1983 mean rainfall and a uniform, unirrigated land cover. Scenario study areas may differ from the WRPP areas.

Groundwater Availability

The Central ASEA includes four aquifer systems: Paia, Kahului, Kamaole and Makawao aquifers. The `Iao and Waihe`e aquifer systems on the eastern side of West Maui Mountain are the principal sources of domestic water supply for the island of Maui, including the Central ASEA. The groundwater sustainable yield (SY) is the maximum rate that groundwater can be withdrawn without impairing the water source as determined by the Commission on Water Resources Management (CWRM). Generally, SY is conservatively set at the low end of the estimated range of predicted sustainable yields for an aquifer. Updated SY for the entire state is under review for the pending 2017 State Water Resource Protection Plan. The total sustainable yield of the Central ASEA is 26 mgd, as established by the Commission on Water Resource Management (CWRM) in 2008. SY is believed to be the best estimate based on available hydrologic data. The CWRM ranks confidence in SY data dependent on available hydrologic studies, deep monitoring wells and established pumping records, ranging from (1) most confident to (3) least confident. Kahului and Pa`ia aquifer SY are ranked as (2) moderately confident and Makawao and Kamaole aquifers are ranked (3) least confident, recognizing that there is significant uncertainty associated with the SY due to the lack of hydrogeologic and pumpage information.[17]

Figure 15-3 Central ASEA Aquifer Systems and Sustainable Yield

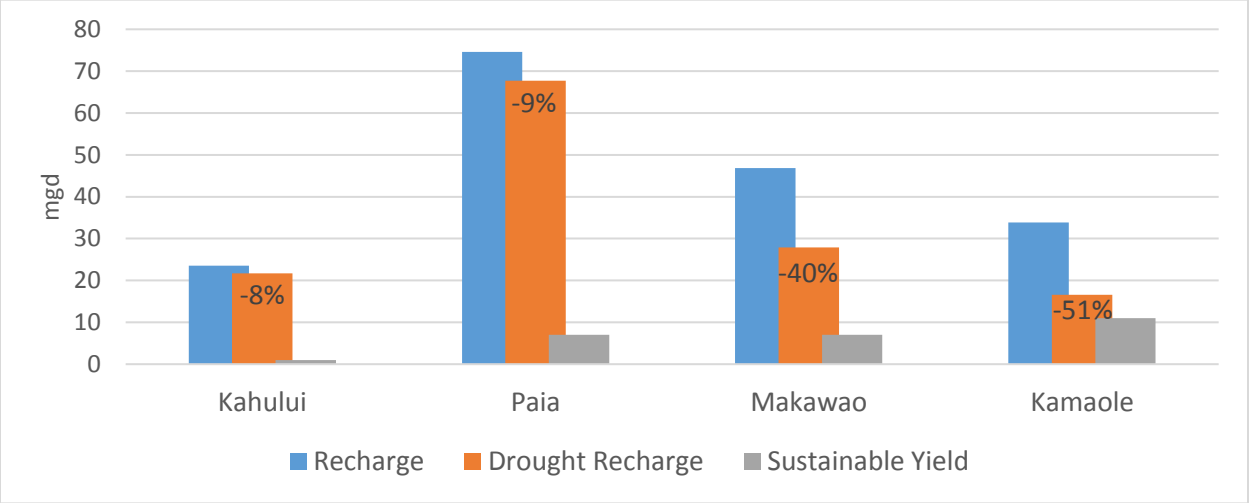


Aquifer System	Aquifer Code	Sustainable Yield Range (mgd)	Sustainable Yield (mgd)
Kahului	60301	1	1
Pa`ia	60302	7-8	7
Makawao	60303	7-20	7
Kama`ole	60304	11-16	11
Total			**26**

[17] CWRM, Water Resources Protection Plan, 2008 pp 3-82.

Sustainable yield accounts only for basal ground water and equals a fraction of estimated recharge. In a basal lens, the fraction is usually more than half of the total groundwater recharge. According to the State Water Resources Protection Plan, 2008, about three-fourths of the recharge of high-level aquifers can be taken as sustainable yield. For planning purposes, recharge during long term drought conditions, hydrologic drought, should be considered as it impacts sustainable yield estimates over time. However, the WUDP updates will monitor continuous SY updates by CWRM and adjust accordingly. Recharge compared to sustainable yield for this aquifer sector is illustrated in the figure below.

Figure 15-4 Average Mean Recharge under Average Climate and Drought Conditions by Aquifer System, Percent Recharge Reduction during Drought, and Sustainable Yield (mgd)

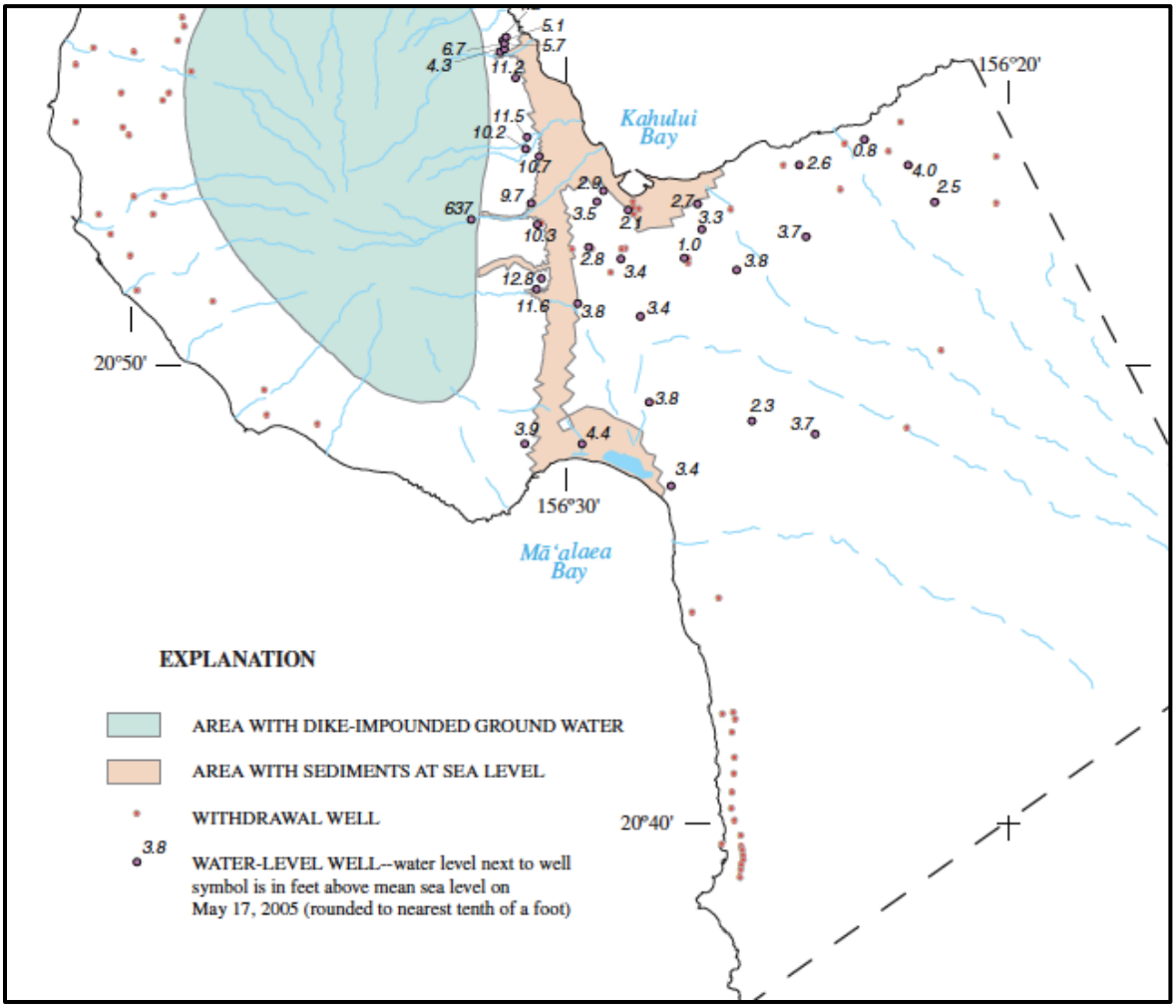


Source: CWRM 2008 Sustainable Yields, USGS, Spatially Distributed Groundwater Recharge Estimated Using A Water-Budget Model For The Island of Maui, Hawai'i, 2014

Sustainable yield does not account for water transfers, such as irrigation return flow that percolates back into the aquifer to be potentially re-pumped. Surface water is conveyed from the Ko`olau ASEA to the Central ASEA via the EMI aqueduct system, and from the Wailuku ASEA via the Wailuku Water Company system. The impact on "available" groundwater that can be extracted from the Kahului and Paia aquifers from irrigation return flow is highly uncertain since the cessation of sugarcane cultivation in 2016. Groundwater levels are also an indicator of changes in recharge or withdrawals and can be an indicator of freshwater lens thickness. In the 2008 USGS groundwater study of the area, measured water levels were lowest near the coast and increase inland toward the recharge areas of West Maui and Haleakala Volcano. A synoptic water level survey in 2005 measured water levels with no pumpage over a period of time. Water levels ranged from 0.84 feet above sea level near the coast to about 637 feet AMSL in dike impounded aquifers of the Wailuku ASEA. The figure below shows water levels measured in 2005. There are no monitoring wells in the Central ASEA aquifers to gage water level changes over time. A simulated scenario in the 2008 USGS study modeled additional recharge from restored streamflow and complete removal of irrigation return recharge. The latter decreased water levels and increased salinity in the central isthmus while recharge

through streams significantly increased water levels, thickens the freshwater body and decreased salinity at withdrawals sites in the Wailuku ASEA. [18]

Figure 15-5 Central ASEA Groundwater Levels Measures in 2005 (Feet Above Mean Sea Level)



Climate Change Impact on Groundwater Availability

The Pacific Regional Integrated Sciences and Assessments' (Pacific RISA) *Maui Groundwater Project* is an interdisciplinary research effort to inform decisions about the sustainability of groundwater resources on the Island of Maui under future climate conditions. A new hydrologic model is being used to assess the impact of changing climate and land cover on groundwater recharge over the Island. Preliminarily future climate projections for Maui Island suggest that wet areas get wetter with mean annual rainfall increases. Scientists' confidence in trends and changes to rainfall and associated recharge is relatively low. No stream flow projections are available for the coming century. The impact on recharge and stream flow from climatic changes at the time of this plan is highly uncertain.

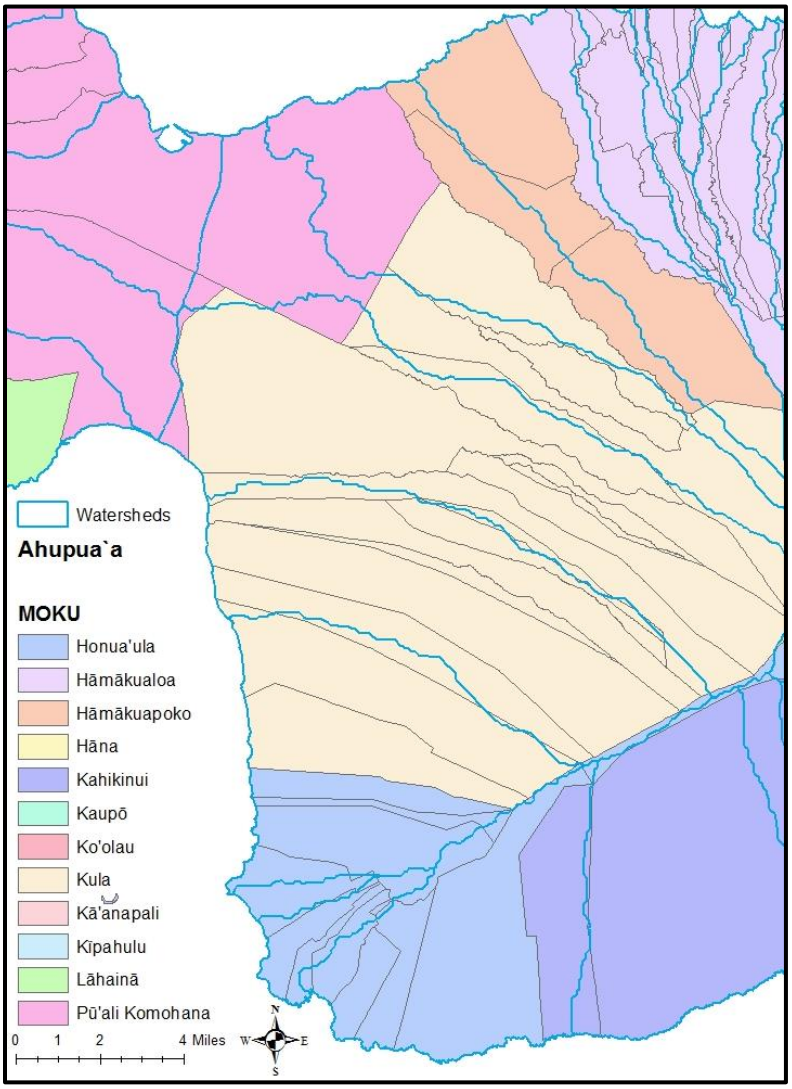
[18] USGS, 2008 Groundwater Availability in the Wailuku Area, Maui, Hawaii Sir 2008-5236

Two ongoing USGS studies initiated in 2015 assess the impact of land-cover changes on past and future groundwater recharge on Maui, and they also assess the hydrologic impact from native versus alien forested watersheds. Study results and improved methods of estimating fog interception, including forest canopy interception and the differentiation of native and alien forests could potentially affect future estimates of sustainable yield.

Moku and Watersheds

The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries than aquifer sectors. The majority of the Central ASEA lies within the Moku of Kula, with portions of the Central isthmus also encompassing the moku of Pu`ali Komohana and Hamakuapoko, and to a minor extent the Moku of Hamakualoa. The southernmost portion of the ASEA is encompassed by the Moku of Honua`ula.

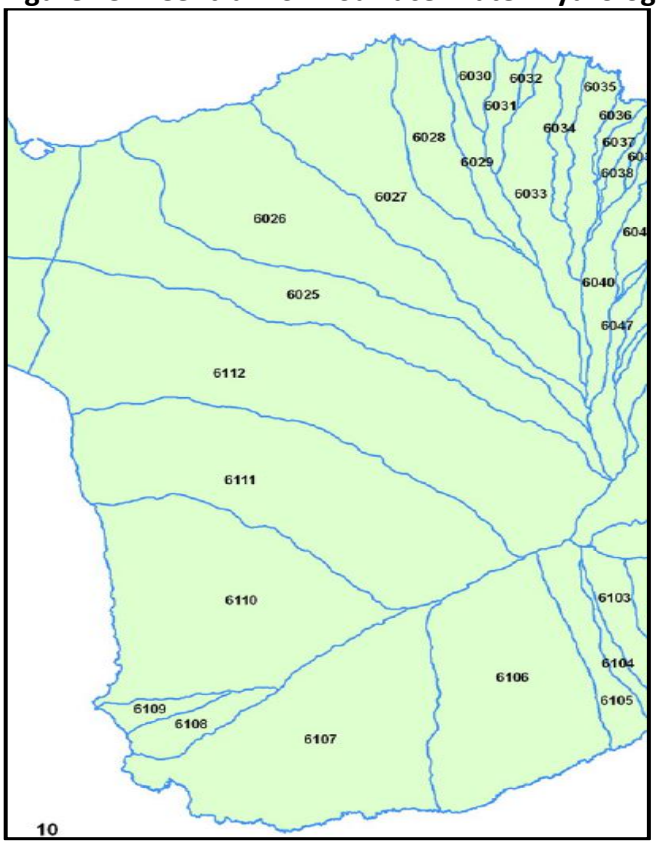
Figure 15-6 Central Aquifer Sector Moku and Watershed Boundaries



Surface Water Availability

Surface water hydrologic units, or Watershed units, are shown below but not further utilized for resource assessment and analysis.

Figure 15-7 Central ASEA Surface Water Hydrologic Units



Hydrologic Units

6001	Waikapu
6002	Pohakea
6024	`Iao
6025	Kalialinui
6026	Kailua Gulch
6027	Maliko Gulch
6040	Kailua
6105	Manawainui*
6106	Kipapa*
6107	Kanaio*
6108	Ahihi Kinau**
6109	Mo`oloa**
6110	Wailea**
6111	Hapapa**
6112	Waiakoa**

Source: Hawaii Stream Assessment, Report R84, December 1990.

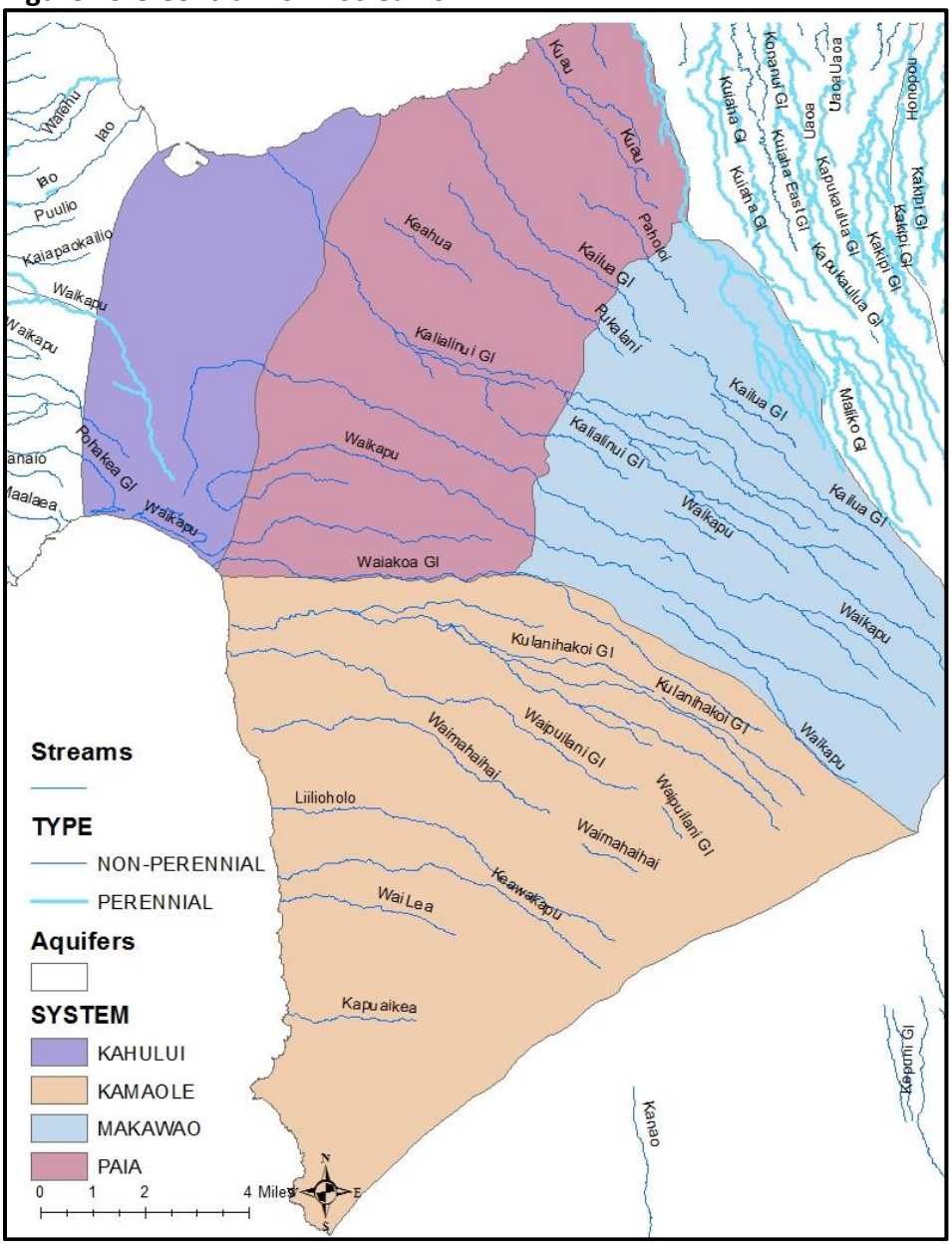
There are no perennial streams in the Central ASEA, except for Maliko Gulch which makes up the boundary to Ko`olau Aquifer Sector and Waikapu Stream, originating in Wailuku ASEA. Recently restored flows of 2.9 mgd just below the South Waikapu Ditch from Waikapu Stream has resulted in the stream recharging Kealia Pond overlying the Kahului aquifer. According to the National Wildlife Refuge staff at Kealia Pond, since the flow restoration, pumpage from wells at the refuge has not been necessary.

The interaction of surface water resources and use between the Wailuku, Central and Ko`olau aquifer sectors is extremely complex from a hydrological and legal standpoint. The availability of surface water from Wailuku ASEA is subject to the ongoing contested case and instream flow standards explained in Chapter 14.2.2. Surface water use from Na Wai Eha in the Central ASEA is assessed below in Chapter 15.5.

The Maliko surface water unit has five stream diversions and is part of the East Maui Irrigation System. Availability of surface water from Ko`olau ASEA is addressed in the Ko`olau aquifer sector report, Chapter 16.2.2 Surface water use in Central ASEA from streams diverted through the EMI system is assessed below in Chapter 15.5. Streams on windward Haleakalā in the

Ko`olau ASEA are fed by abundant rainfall and groundwater discharge.[19] In the area between Makawao and Ke`anae Valley, groundwater discharges to streams from a perched, high-level saturated groundwater system.

Figure 15-8 Central ASEA Streams



Registered diversions are limited to four spring diversions along the south east boundary of Makawao aquifer, none of them reported in use. It's possible that a more extensive forested watershed provided fresh water at the Ulupalakua springs in the past.

[19]Gingerich, S.B., 1999b, Ground-water occurrence and contribution to streamflow, northeast Maui, Hawai`i: U.S. Geological Survey Water-Resources Investigations Report 99–4090, 69 p.

Table 15-2 Central ASEA Surface Water Diversions, Gages and Proposed IIFS by Watershed Unit

Aquifer System	Hydrologic Unit Code	Hydrologic Unit	Area (mi^2)	Total Diversions per Watershed Unit	No. of Gages per Watershed Unit
Makawao	6025	Kalialinui	30.28	0	3
Makawao	6026	Kailua Gulch	29.76	0	0
Kama`ole	6108	Ahihi Kinau	3.68	0	0
Kama`ole	6109	Mo`oloa	1.9	0	0
Kama`ole	6110	Wailea	35.76	4	2
Kama`ole	6111	Hapapa	40.89	0	1
Pa`ia	6112	Waiakoa	55.76	0	2
TOTAL			**198.03**	**4**	**8**

Source: CWRM, *State Water Resources Protection Plan*, 2008.

Transport of Stream Water from Nā Wai `Ehā

The four streams Waihe`e River, Wailuku River (formerly `Iao Stream), Waiehu and Waikapū Streams of Nā Wai `Ehā provide surface water through the Wailuku Water Company ditch system for use in the Central ASEA. The CWRM designated Nā Wai `Ehā a surface water management area in 2008 and the streams are subject to an ongoing contested case. Stream flow and status of Interim Instream Flow Standards are assessed in Chapter 14.2.2.

Transport of Stream Water from East Maui

Streams in the Ko`olau ASEA, bordering Kuhiwa Aquifer System (ASYA) to the west, are subject to the East Maui Contested Case due to significant diversions by East Maui Irrigation Company (EMI) to Central Maui. Water from Ko`olau ASEA is transported to the Central ASEA for agricultural and municipal uses. Streamflow and the status of the contested case is assessed in Chapter 16.2.2.

15.3 Settlement Patterns and Cultural Resources

This section strives to acknowledge and highlight how Hawaiian history and cultural practices of the past relate to the present, and how those traditions can inform options for meeting the future water needs of the people of Maui Island, while preserving and celebrating Hawai`i's past. Archaeological remains and traditional Native Hawaiian culture-history provide a foundation for establishing continuity between past, present and future water use in the Central ASEA. Population fluctuations within the last 200 years have largely occurred due to changes of land ownership, droughts and the establishment of homesteads.[20]

Early Hawaiian settlement is evident from the large numbers of archeological sites within the region. There are numerous recorded and unrecorded Heiau, stone walls, building platforms and petroglyphs which provide evidence of intensive habitation and land use well before 1778 when Captain Cook arrived in the Hawaiian islands.[21]

15.3.1 Historical Context

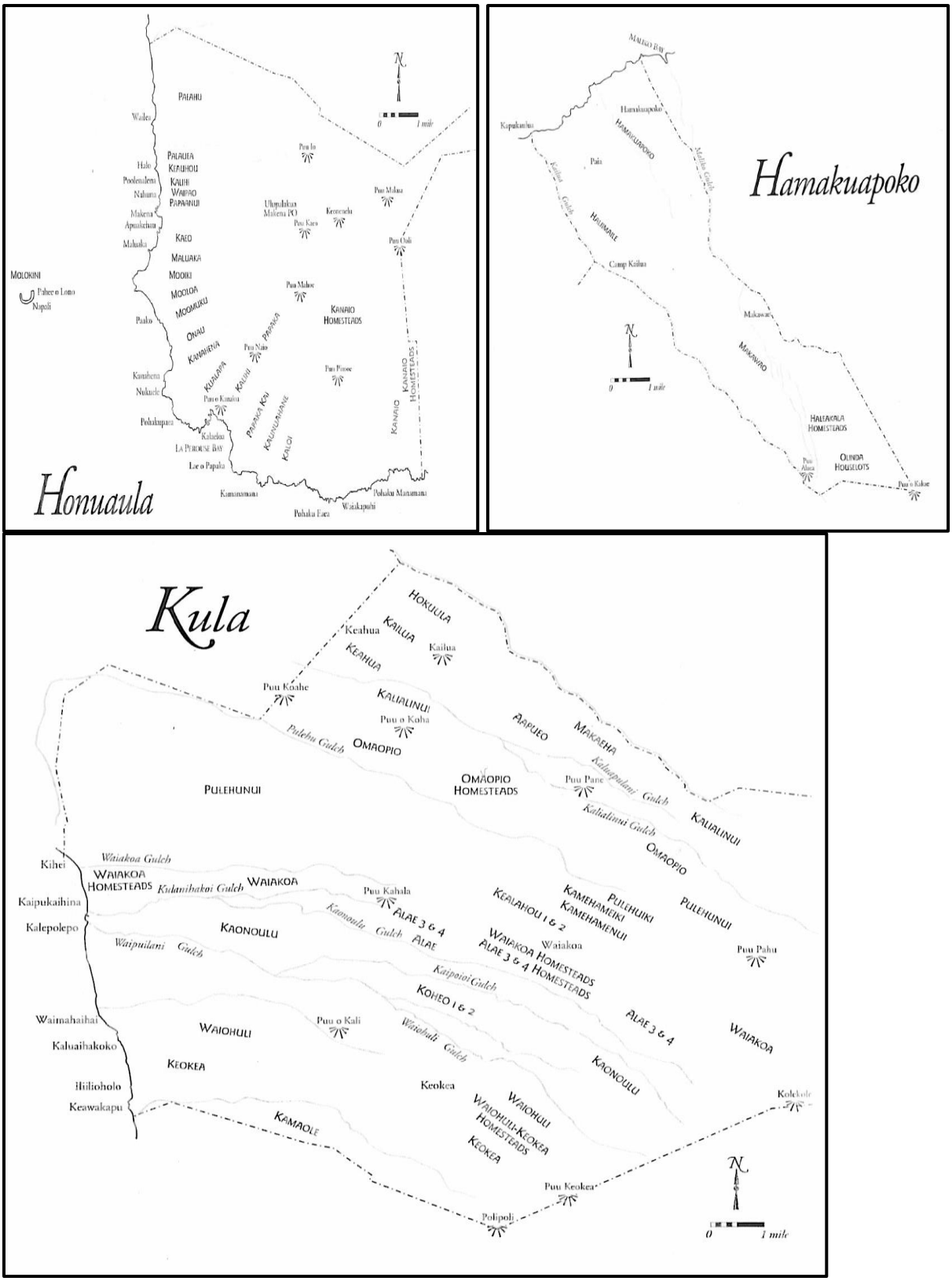
Maui County's original inhabitants developed a unique system of land and ocean tenure and use that divided land into large sections called moku. Typically, each moku is comprised of many ahupua`a. An ahupua`a is a land division unit that extends from the upland mountain top to the sea, and usually includes the bounding ridges of a valley and the stream within.

Boundary Delineations

The Central ASEA spans multiple moku that are generally more aligned with watershed boundaries and ahupua`as than aquifer sectors. The majority of the Central ASEA lies within the Moku of Kula, with portions of the Central isthmus also encompassing the Moku of Pu`ali Komohana and Hāmākuapoko, and to a minor extent the Moku of Hāmākualoa. Present day Mākena is located in the southernmost portion of the Central ASEA and is encompassed by the Moku of Honua`ula. Historical and contemporary boundary delineations of Kula differ from the boundaries identified by the aquifer sector areas used by the WUDP. The historical delineation is bounded on the west by Pulehunui in the central Maui isthmus, Kaluapulani Gulch to the north and east, on the south, moving from the west, Kama`ole, Kēōkea, Kaonoulu, and Waiakoa. The DLNR Kula Aquifer Sector Area includes the Central Maui aquifers of Makawao, Kama`ole and a portion of Paia. Historically, the district extended to the shoreline of Kīhei, but the shorelines of Ma`alaea, Wailea and Mākena were excluded. In recent times, Kula is considered to run approximately from approximately the 1,000-4,000 foot level on the inland-facing flank of Haleakala that abuts the central Maui isthmus, located between Maui's two mountain ranges. Today, most people think of Kīhei and Kula as disconnected areas because there is no public road directly connecting them.

[20] County of Maui, Makawao-Pukalani-Kula Community Plan, page 11.
[21] Ibid, page 28.

Figure 15-9 Kula, Hamakuapoko and Honua`ula Moku



Source: Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997.

Hāmākualoa Place Name

On the wetter side of the Central ASEA, Hāmākualoa, the place name reflects the influence of rain, “Ka ua pe`e puhala o Hāmākua,” means the rain of Hāmākua that makes one run to the hala tree to hide.”[22]

15.3.2 Historic Agriculture

Previously, during the 1900s, Kula was an agricultural breadbasket for both Maui and O`ahu, but not all crops thrived there. In recent decades, the region has become famous for the quality of vegetables and flowers exported to Hawaiian and international markets.

Kula and Hāmākuapoko Staples

Smaller scale farming in Kula was actually begun by the pre-1778 Hawaiians and the area was especially known for its `uala or sweet potatoes. The cool and relatively dry climate, as well as exceptional soil, makes the Kula area excellent for a number of crops and for many years it has been the center of the island’s diversified agriculture industry.[23]

Handy writes about the cultivation of crops within the ancient Moku of Hāmākuapoko.

> “The deep gulch of Maliko Stream widens at its seaward end into a flat-bottomed valley which, in pre-sugar days when the stream had constant flow, harbored a number of terraces. The gradually rising land of Hāmākuapoko in earlier times would have been suitable for dry taro but not for wet. It was probably well-populated and cultivated, for the kula land east of Maliko was a small patchwork of ahupua`a.”[24]

15.3.3 Historic Water Scarcity

Handy writes, "Kula was always an arid region, throughout its long, low seashore, vast stony *kula* lands and broad uplands. Both on the coast, where fishing was good, and on the lower westward slopes of Haleakala, a considerable population existed.[25]

East Maui’s Historical Contribution to Upcountry Agriculture

In order for historic Upcountry farming to have flourished since the 1800s, surface water from East Maui was transported via a 17-mile aqueduct system.

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[22] Baker, Edward to M.k. Pukui, Mar. 25-April 1, 1960, MS SC Sterling 3.12.3 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 97].
[23] County of Maui, Makawao-Pukalani-Kula Community Plan, page 10.
[24] Ibid, page 109.
[25] Ibid, page 242.

"Kula today is naturally dry area, dependent for farm irrigation on a man-made pipeline system extending from Waikamoi, at the edge of the remaining windward rain forest belt on the east flank of Haleakala…"[26]

In 1876, the construction of Hāmākua Ditch brought water to the dry central valley and northwestern slopes of Haleakala, making sugar production possible where once only scrublands existed. Captain James Makee's "Rose Ranch" at Ulupalakua produced sugar cane until the destruction of the forest above the ranch by cattle and other causes reduced the total rainfall and made sugar an unprofitable venture.[27]

Pre-1778 Water

Ancient Hawaiian lore tells of the clouds always encircling the mountain, creating enough fog drip precipitation to generate underground water and ocean springs.

"Makali`i told me about the Cloud Warriors, Naulu and Ukiukiu-trade-wind driven clouds split by the height and mass of Haleakala into two long arms. Naulu traveled along the southern flank of the mountain, Ukiukiu along the northern and they battled forever to possess the summit. Usually Ukiukiu was victorious, but occasionally Naulu pushed him back."[28]

Despite the comparative lack of water resources, a fairly sizable population existed along the south Maui shorelines and on the inland slope of Haleakala.

"On the coast, where fishing was good, and the lower westward slopes of Haleakala, a considerable population existed, fishing and raising occasional crops of potatoes along the coast, and cultivating large crops of potatoes inland, especially in the central and northeastern section including Kēōkea, Waiohuli, Koheo, Kaonoulu, and Waiakoa, where rainfall drawn round the northwest slopes of Haleakala increases toward Makawao."[29]

According to Handy, there was probably little human settlement in ancient times before European contact between Kīhei and Mākena.[30] The moku of Honua`ula straddles the Maui Department of Water Supply's (MDWS) Central Aquifer Sector's Kama`ole System and Kahikinui ASEA's Luala`ilua System. At the time of the census in 1831, Honua`ula was the 4th largest population center on Maui; however, today, it is one of the least populated areas on Maui.[31]

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[26] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].
[27] County of Maui, Makawao-Pukalani-Kula Community Plan, page 9.
[28] A. von Tempski, Born in Paradise, page 14. [Sterling, Elspeth P. Sites of Maui. Bishop Museum Press, 1997, page 243].
[29] Ibid, page 243.
[30] E. S. C. Handy. Hawaiian Planter, The Museum, 1892, page 159.
[31] Kawa`a, Luana, Cultural Survey & Moku Inventory: Moku of Kipahulu and Hana, Island of Maui (Draft), Ka Piko O Ka Na'auao (The Hawaiian Learning Center), 2009, page 3.

Prior to the introduction of cattle, the forest zone of this region was much lower and rainfall more abundant. Forest zone plants grew profusely in this area, and dryland taro and sweet potatoes were cultivated.[32]

Post-1778 Human-influenced Environmental Change

Today, with one exception there are no perennial streams flowing to Maui's central isthmus from either mountain; but in the past, there was a time when water was more abundant, and the streams of Haleakala and Mauna Kahalawai's (West Maui) waters met.

> "Kaopala is where the water from the mountains (the acclivities of east and west Maui) meet. The former name of the place now called Kaopala, was Kailinawai because there the waters of the two mountains joined…"[33]

Watershed Destruction

The native forest once produced significantly more fog-drip precipitation that percolated underground to the coastline, where there were extensive freshwater ponds in Kīhei and Ma'alaea Bay, located along the shoreline below present day Kula. Looking up the central Haleakala mountain flank, one can see that 70% of the forest has been destroyed. Some of the causes of destruction are: (1) sandalwood trade with China in the early 1800s; (2) deforestation for cattle grazing; and (3) deforestation for growing vegetables for whaling ships and the California Gold Rush in the 1800s.

> "'The destruction of the forest in Kula was completed by the ranchers clearing for pasture'. Korte said…Before the forests were cut down, he said, it was possible to fill a sizable tank with water from cloud drip in Kula during one night…A secondary result of the clearing of the Kula forests, he said, was the destruction of extensive fresh water ponds in Kīhei, on the Ma'alaea Bay coast below Kula…When the forest was cleared, water was free to rush down the mountain, carrying soil from Kula to the coast and filling with mud the ponds for which Kīhei was once famous."[34]

Drought and Famine

The success of agriculture in Kula in both past and modern times has varied depending on the amount of rain produced. In times of famine, people have had to resort to eating "famine foods" as a drastic measure to deal with the lack of water and agricultural productivity in times of drought.

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[32] ibid, page 7.

[33] Opinion of the Court by McCully, J., in the Matter of the Boundaries of Pulehunui. Hawaiian Reports, 1879. 4:239 – 255 [Sterling, Elspeth P. Sites of Maui. Bishop Museum Press, 1997, page 254].

[34] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].

"Many people came there to play games and to go swimming in a pool, Waimalino. Kula and a part of Makawao were waterless lands, and so this pool became a place where all enjoyed themselves and danced hulas…There was a famine in Kula and Makawao, and the people subsisted on laulele, paulele, popolo, and other weeds."[35]

Droughts are a natural phenomenon historically experienced throughout the Hawaiian islands, but historic activities since 1778 have drastically contributed to environmental destruction that has resulted in more intense droughts than previously resulted from natural weather cycles.

"…the Kula farming area, now suffering from drought, lost its natural supply of water as a direct result of the California gold rush that started in 1849…This is according to research into old records as reported by Karl H. Korte, Maui District Forester for the State Department of Land and Natural Resources…The current drought is due to weather conditions that have interrupted the normal flow of moist trade winds against windward East Maui…But, Korte said, before 1850 Kula was supplied with moisture naturally through the existence of a large forest…'That forest was cut down when land was cleared in Kula to open farm plots in 1850. This was in answer to the demand for food in California during the gold rush'. Korte explained…He said the explanation can be found in old records, which he has seen."[36]

15.3.4 Hawaiian Culture Today

Historic sites and cultural resources provide evidence of Central Maui's history and serve as tools for conveying the heritage of the region to its youth as a legacy for the future. Today, the areas that make up the Central ASEA: south Maui, Upcountry, and Central Maui; contain numerous ancient archaeological sites and host events that support traditional Native Hawaiian cultural/community groups such as hula halau and outrigger canoe clubs, helping perpetuate the traditional Native Hawaiian culture. The Maui Arts and Cultural Center opened in 1994 as the culmination of a long-standing dream of Maui's residents to build a world-class gathering place for the arts, and is committed to the past, present and future of Maui, through entertainment, education, Hawaiian cultural programming. There are no kuleana parcels identified within the Central Aquifer Sector.

15.3.5 Lessons Learned from the Past

Historic regional water transportation/sharing strategies from East Maui to Upcountry have affected the practice of Native Hawaiian culture in the East Maui region. Historic practices and infrastructure designed to maximize diversions of stream flow for transport to arid regions are not sustainable today. In establishment of Instream Flow Standards, CWRM takes into account

[35] Lucy K. Henriques. Paper read before the Hawaiian Historical Society, Fall Meeting, 1916. *Hawaiian Ethnological Notes,* 2:214 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 244].
[36] Kula Farm Area's Drought, Sunday Star-Bulletin and Advertiser, July 1, 1962, A15 [Sterling, Elspeth P. *Sites of Maui.* Bishop Museum Press, 1997, page 245].

instream and offstream needs. There is community sentiment that favors developing areas with regional existing water resources, rather than transporting water from wet regions. Upcountry farmers are in favor of transporting agricultural water and residents seeking home development are at odds with East Maui residents who favor leaving the water in the streams.

Watershed Management

The Kula region encompasses a rural area whose water needs are mostly fed by a combination of transported east Maui water formed from orographic precipitation and Upcountry fog drip formed by clouds moving through the forests. In the past, the area's fog drip precipitation supported a number of springs, anchialine pools, Hawaiian villages and a much larger Native Hawaiian population; but environmental change, disease, gentrification, and a drastic shift in the cultural landscape has reduced the Native Hawaiian population, traditional resources, and those that live by those cultural traditions. Additionally, the natural fog-drip precipitation has been drastically reduced due to historic deforestation of sandalwood and other native trees, cattle grazing and vegetable farming for whaling ships and the California gold rush during the 1800s; therefore, Native Hawaiian upslope agriculture and nearshore aquaculture have been severely diminished by changing weather patterns (global warming) and human-induced environmental degradation (deforestation). Ahupua'a management measures that include watershed management and reforestation could facilitate more fog-drip precipitation and the resulting increased capacity for Native Hawaiian agriculture and cultural practices on Kula lands over a longer timeframe than the WUDP's 20-year planning period. Reforestation and watershed management efforts could also benefit native Hawaiian cultural practitioners by increasing water in downslope nearshore wetlands and fishponds in Kīhei and Mākena. Those downslope areas are hydrologically connected to upslope kula lands by way of underground mauka-to-makai water flow that surfaces at the ocean saltwater/freshwater interface, due to the denser saltwater forcing the less-dense freshwater up to form springs along the shoreline.

DHHL Water Resources

Due to the extensive Department of Hawaiian Homelands (DHHL) land holdings and their plans to further develop the area for Native Hawaiian habitation and farming activities; adequate water supply is becoming increasingly important for Native Hawaiians to resettle and facilitate their cultural practices in the area. DHHL lands are occupied by Native Hawaiians who are assumed to live the full-range of traditional Native Hawaiian cultural practices based on their ability to implement the knowledge of their heritage. Upcountry Maui (Kēōkea/Waiohuli, Ulupalakua, Kualapa) has over 6,000 acres of DHHL lands. The Makawao-Pukalani-Kula Community Plan section, "Identification of Major Problems and Opportunities of the Region Problems," cites "limited development of water resources and distribution system to meet the needs of the region as a primary concern," and notes that "The proper allocation of water resources is considered essential to encourage the development of Department of Hawaiian Home Lands (DHHL) parcel."[37]

[37] County of Maui, Makawao-Pukalani-Kula Community Plan, page 12.

Water use in the Upcountry region, including DHHL needs, is recognized as having impacts on the streams of East Maui and the agricultural activities of the central valley. A comprehensive water management strategy is needed to strike a balance between the various interests and accommodate environmental, agricultural and residential needs of all neighboring regions.[38]

[38] Ibid, page 15.

15.4 Land Use

The isthmus between west and east Maui have been used for agriculture for over a century. Urban areas spread over the northern part of the isthmus at Wailuku and Kahului and along the south shore from Maalaea to Makena. The area known as Upcountry, roughly located between 1000 – 4000 feet elevation is bounded in the west by the HC&S plantation and extends out to Keokea in the south. Upcountry is distinctly isolated from the urban regions on the isthmus with no road connection south of Haleakala Highway. The aquifer sector encompasses urban, rural and agricultural land uses, each with unique challenges and opportunities.

15.4.1 Land Use Plans

Urban infill and planned growth areas for the Central ASEA are identified in the Maui Island Plan (MIP). The MIP provides policy direction to enhance agricultural lands, protect the rural character and scenic beauty of the countryside and direct growth to appropriate areas. When urban development is needed to accommodate growth, it is almost inevitable that agriculturally zoned land will be converted. It is the "default" zoning or district and most often borders our urbanized areas. Key issues associated with the land use types in the region as identified in the MIP are summarized below.

Agricultural lands:

- Diminished production capacity associated with fragmentation of agricultural parcels
- Higher land costs to farmers as non-agricultural land uses are viewed by many to be a more profitable investment.
- Social changes as commercial farming may be considered a difficult occupation.
- Affordable housing needs fragment properties through subdivisions
- Reliable and affordable water for viable crops competes with other uses.

Rural lands:

Low density residential sprawl in the regions from Haiku to Ulupalakua due to population growth, development pressures and decreasing agricultural activities

Urban lands:

Less than five percent of Maui's lands are within the State Urban District. The challenge in prudent planning and managed development is to mitigate the impact on agricultural lands, rural communities and natural resources

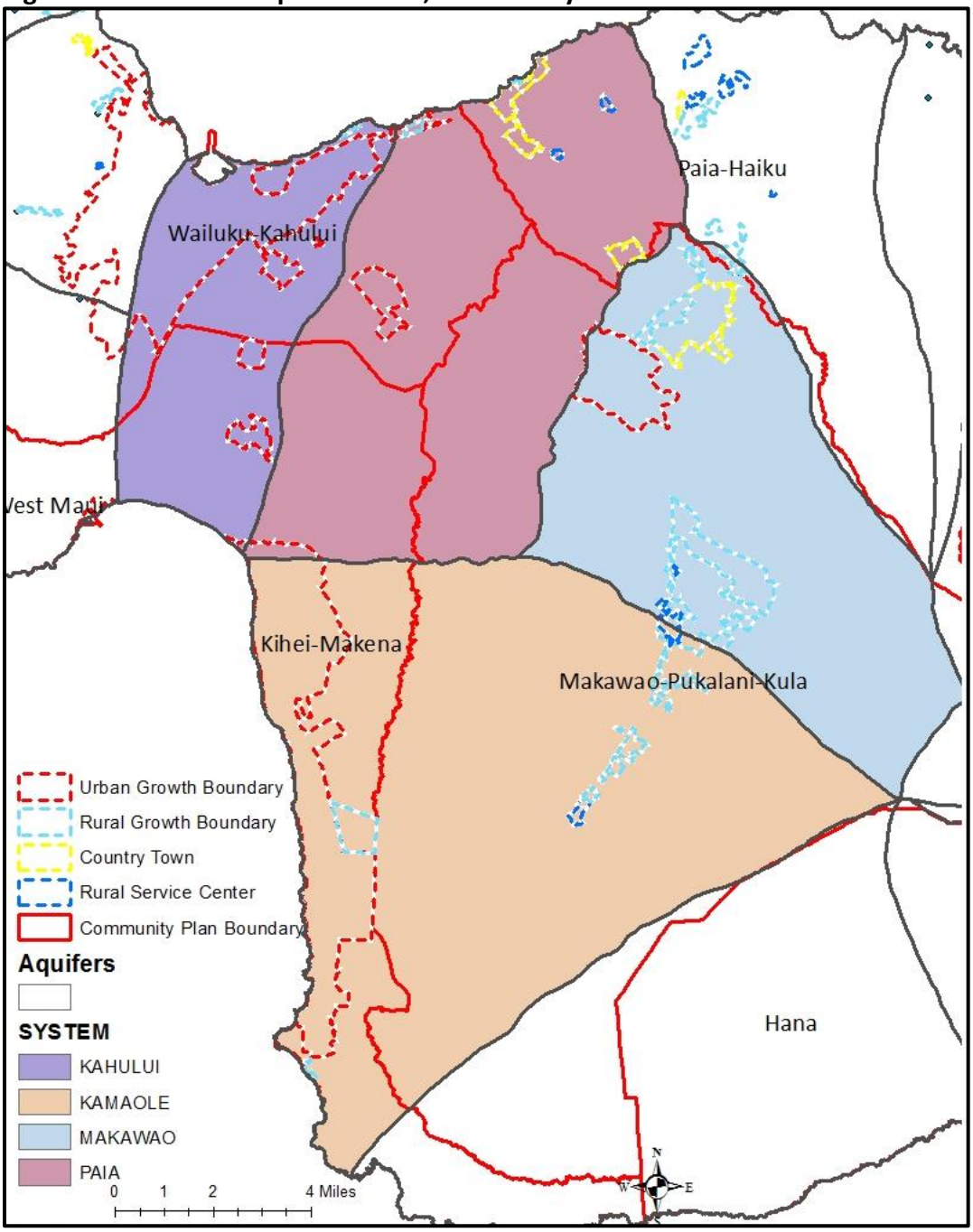
The aquifer sector encompasses four community plan districts:

- Wailuku-Kahului Community Plan, adopted 2002
- Kīhei-Mākena Community Plan, adopted 1998
- Makawao-Pukalani-Kula Community Plan, adopted 1996

- Pā`ia-Ha`ikū Community Plan, adopted 1995

The figure below portrays the relationship of the Wailuku ASEA, community plans and directed growth boundaries.

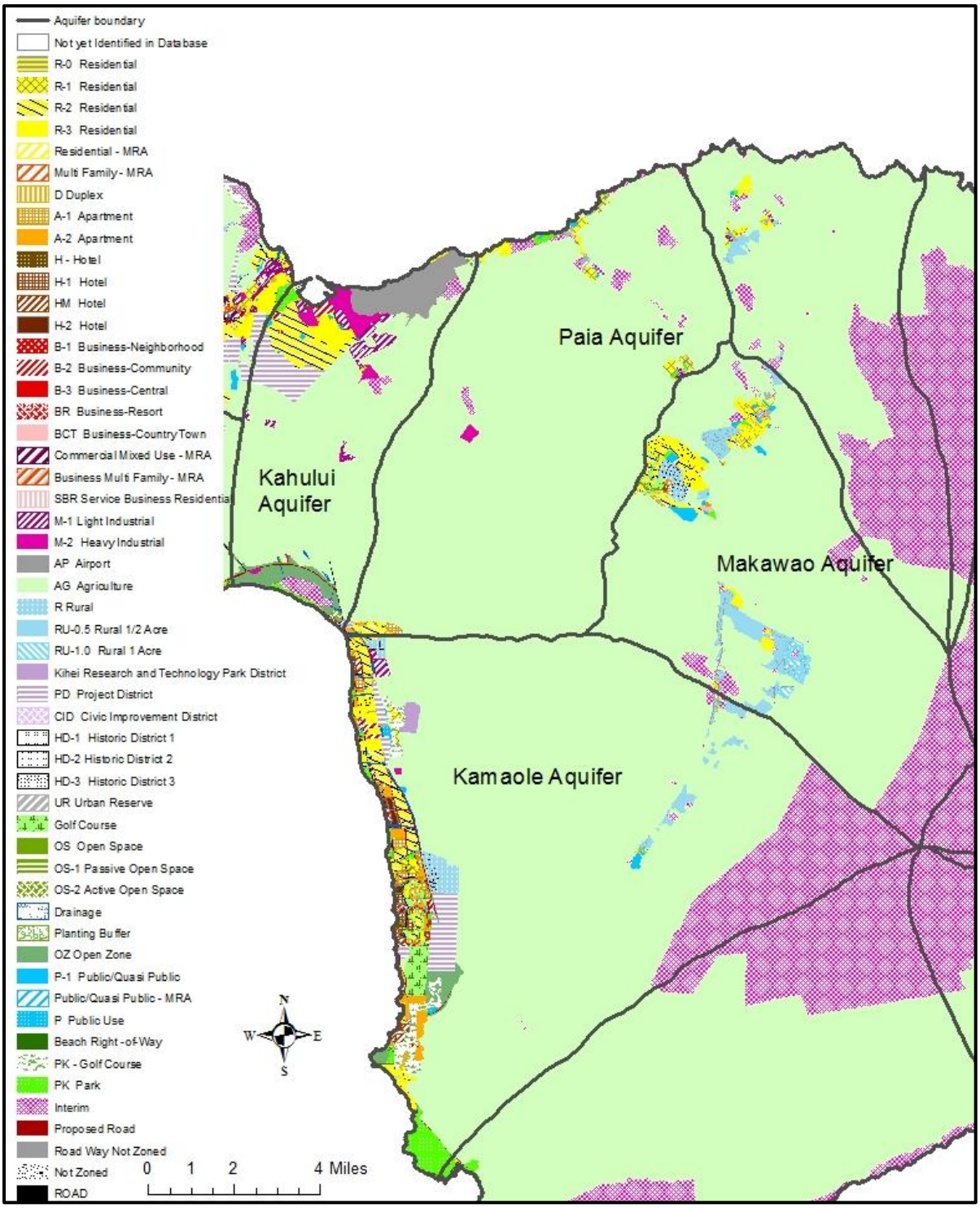
Figure 15-10 Central Aquifer Sector, Community Plans and Directed Growth Areas



Maui County Zoning

Maui County Zoning for this ASEA includes a range of resource, rural and urban zoning districts.

Figure 15-11 Central Aquifer Sector County Zoning Districts



Zoning districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand in the table below.

Table 15-3 Summary of Zoning Use Types, Central ASEA (excluding DHHL lands)

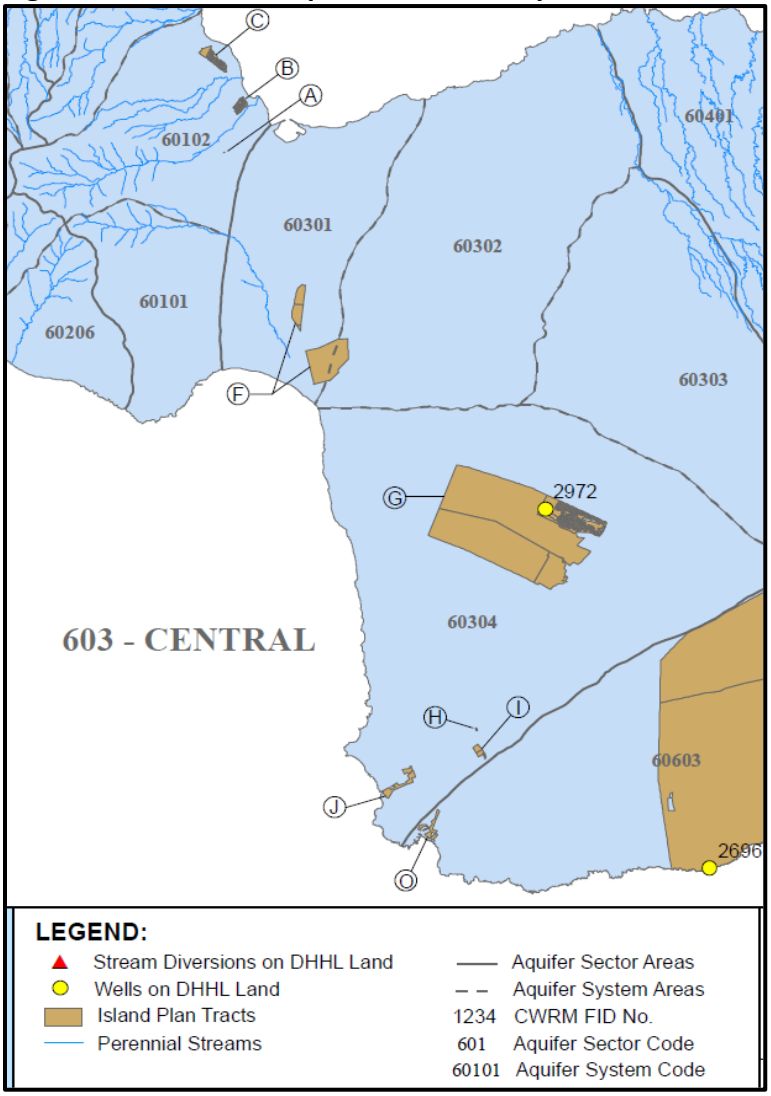
Zoning Summary (Corresponding County Zoning Categories found within the Wailuku ASEA in Parentheses)	Acres	% of Total
SF Single Family Residential, Duplex, Residential (R-0, R-1, R-2, R-3), RU-0.5 Rural)	8,434.03	6.20%
Airport	1,390.96	1.02%
Apartment (A-1 Apartment, A-2 Apartment)	993.41	0.73%
Business (B-1 Business, B-2 Business, BCT Business Country Town)	338.32	0.25%
Industrial	1353	1.00%
Hotel (BR Business – Resort)	437.96	0.32%
Agriculture (AG Agriculture)	118,839.14	87.42%
Golf Course (PK-4 Park - Golf Course)*[5]	900	0.66%
P-1 Public/Quasi-Public, Public Use Park	1,631	1.20%
Open Space	1,623	1.19%
TOTAL excluding DHHL Lands	135,940.27	**100%**

Source: Table prepared by MDWS, Water Resources & Planning Division. Excludes DHHL lands.
Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Interim zoning was assigned to CWRM categories based on Community Plan land use designations. Table excludes 211 acres of DHHL lands zoned Agriculture that are excluded from Agricultural zoning category.

15.4.2 The DHHL Maui Island Plan

Department of Hawaiian Homelands (DHHL) lands are occupied by Native Hawaiians who are assumed to live the full-range of traditional Native Hawaiian cultural practices based on their ability to implement the knowledge of their heritage. There are five DHHL tracts in the Central ASEA as shown in the figure below.

Figure 15-12 Central Aquifer Sector – Department of Hawaiian Homelands Tracts



Source: State Water Projects Plan, May 2017

Kēōkea/Waiohuli – Priority Tract

According to the DHHL Maui Island Plan, with adequate water and funding, this area has the potential to be the largest homestead region on Maui. Over 6,000 acres of DHHL land are located below Kula Highway on the slopes of Haleakala. A 70-unit farm lot subdivision at Kēōkea was planned prior to the *Maui Island Plan*. A second phase of 343 residential lots can be implemented using allocations from the existing water system if planned in the mid-section of the tract between existing residential lots and the Kēōkea farm lots. An additional 768 residential lots are proposed for future residential homesteads at Waiohuli pursuant to the development of an on-site production well.

Kualapa

Located along Kula Highway south of Ulupalakua near Kanaio, this tract does not have immediate development potential due to infrastructure constraints. The water system is old

and undersized and is not able to accommodate any further growth; and extensive off-site improvements would be needed to support residential development.

Kula Residence Lots

The Kula Residence Lots subdivision is located in the northern portion of the Kēōkea-Waiohuli homestead area (yellow on the accompanying map). The subdivision will include a total of 420 lots developed to Rural Residential half-acre standards.

Future DHHL Development

DHHL has long range conceptual plans for about 1,100 more residential lots in the area below the latest developments. The future subdivisions are envisioned to include community facilities, a school site, parks, archaeological preserves, and open space. These future plans are dependent on the development of water, wastewater, road improvements, and funding. The timeframe for these developments is beyond 2020.

15.5 EXISTING WATER USE

Water systems can extend over multiple aquifer units and utilize water resources transported from multiple hydrologic units – aquifers or watersheds. Water use, by type and by resource, are inventoried for the Central ASEA as a hydrologic unit. However, for practical purposes existing water use and future water demand are also analyzed and projected for county and private water systems that share water resources from multiple hydrologic units. For example, the municipal Maui County Department of Water Supply (MDWS) Central Maui system services the region from Waihe`e to Pā`ia-Kuau and south to Ma`alaea, Kīhei and Mākena. The Central Maui system overlies Wailuku ASEA and the Central ASEA. Because practically all freshwater supply for this system generates in the Wailuku ASEA, the Wailuku ASEA Report addressed the MDWS Central Maui system as a whole. This Central ASEA Report focuses on all other water use in the Central ASEA, including the MDWS Upcountry System.

15.5.1 Water Use by Type

The CWRM has established the following water use categories based for the purposes of water use permitting and reporting:

- Domestic (Residential Domestic—includes: (1) potable and non-potable water needs and Single and Multi-Family households, including non-commercial gardening; (2) Non-residential Domestic--includes potable [and non-potable] water needs; Commercial Businesses, Office Buildings, Hotels, Schools, Religious Facilities)
- Industrial (Fire Protection, Mining, dust control, Thermoelectric Cooling, Geothermal, Power Development, Hydroelectric Power, Other Industrial Applications)
- Irrigation (Golf Course, Hotels, Landscape and Water Features, Parks, School, Habitat maintenance)
- Agriculture (Aquatic Plants & Animals, Crops Irrigation and Processing, Livestock Water, Pasture Irrigation, and Processing, Ornamental and Nursery Plants, Taro, Other Agricultural Applications)
- Military (all military use)
- Municipal (County, State, Private Public Water Systems--as defined by Department of Health)

There are 362 wells installed in the Central Aquifer Sector, of which 18 are observation wells, 54 are unused, and seven are unspecified. Active wells and reported pumpage reflect the base year 2014.

There are no streams providing water supply within the Central ASEA. Surface water diversions from the Wailuku ASEA and from the Ko`olau ASEA are imported for potable and non-potable uses.

Table 15-4 Reported Groundwater Pumpage and Diverted Surface Water by Type, Central ASEA, 2014 (mgd)

Aquifer	Domestic	Industrial	Agriculture	Irrigation	Municipal	Military	Total
Kahului	0	0.208[*2]	28.222	0.476	1.093	0	29.999[*2]
Pā`ia	0	0	29.097	0.161	0.248	0	29.506
Makawao	0	0	0	0.220	0.139	0	0.366
Kama`ole	0	0	0	2.826	0.027	0	2.853
Central Total Pumpage	**0**	**0.208**	**57.319**	**3.683**	**1.507**	**0**	**62.724**
% of Pumpage	0%	0.33%	91.39%	5.87%	2.40%	0%	100%
Total Number of Production Wells	6	21	22	172	17	0	238
Total Diverted Surface Water[*4]	0	0	0.003[*3]	0.003[*3]	0	0	0.007
Reclaimed Wastewater[5]	0	0	0	1.830[*5]	0	0	1.830[*5]
WAILUKU GW IMPORT	0	0	0	0	15.654	0	15.654
WAILUKU SW IMPORT	0	0	18	0	0	0	18
WAILUKU TOTAL IMPORT	0	0	18	0	15.654	0	33.654
KO`OLAU SW IMPORT	0	0	116.133	0	5.632	0	121.765
KO`OLAU TOTAL IMPORT	0	0	116.133	0	5.632	0	121.765
CENTRAL TOTAL USE	**0**	**0.208**	**191.455**	**5.516**	**22.793**	**0**	**219.973**

[*2]Does not include 53 mgd of groundwater use from wells located near coastal areas recently declared by MECO. This should be accounted for in future WUDP updates.

[*3]0.0069 mgd use unknown, assumed to be either Irrigation or Agriculture, so 0.003452 mgd distributed between both categories.

[*4]Sourced from within Central ASEA (does not include imported surface water from Wailuku and Ko`olau ASEAs)

[*5]Wastewater generated within the Central ASEA is treated at the Kahului Wastewater Treatment Facility, east of Kahului Harbor, and the Kīhei Wastewater Treatment Facility. All reclaimed water is utilized within the Central ASEA.

Figure 15-13 Reported Pumpage by Well Type, Central ASEA, 2014 (mgd, percent)

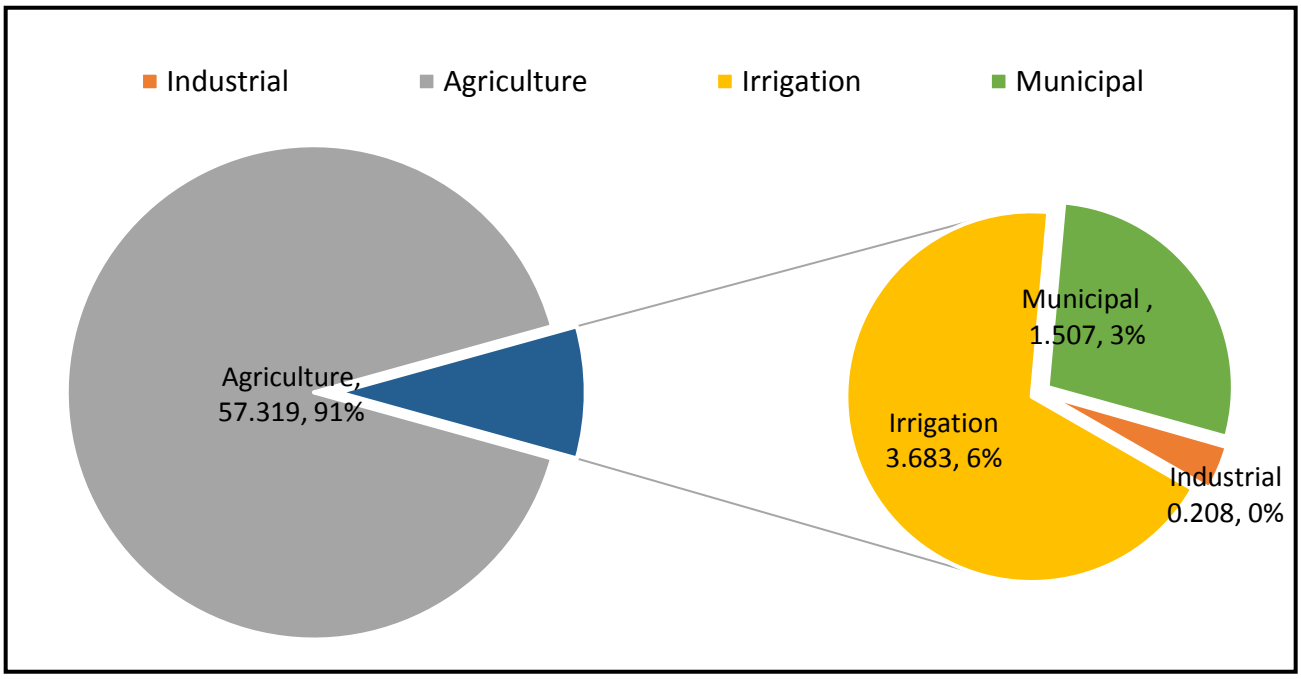
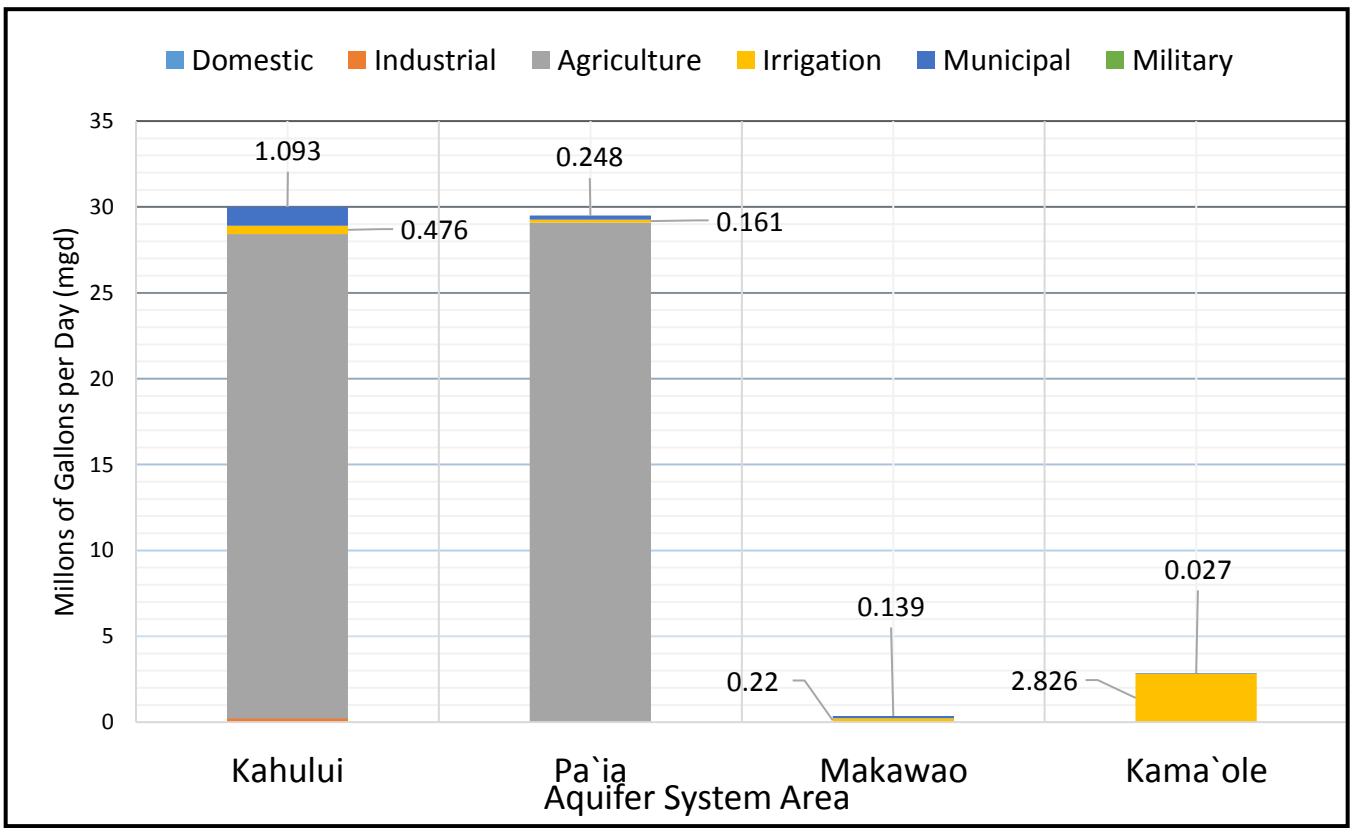


Figure 15-14 Reported Pumpage by Well Type and Aquifer System, Central ASEA, 2014 (mgd)



Domestic Use

Domestic use is defined in the State Water Code as "any use of water for individual personal needs and for household purposes such as drinking, bathing, heating, cooking, non-commercial gardening, and sanitation".[39] The code does not quantify the amount of water that would qualify for domestic use.

According to the CWRM well database, there are six wells classified as Domestic within the Central ASEA. It is likely that domestic use is underreported. The largest portion of customers served by the municipal MDWS system are for domestic type uses – serving individual households. These users are included under Municipal Use and compared to other customer classes served by MDWS.

Military Use

There are no wells classified as Military use within the Central ASEA.

Industrial Use

There are 21 wells that produce 0.208 mgd classified as Industrial use within the Central ASEA, all withdrawing from the Kahului aquifer. Although MECO uses 53.00 mgd of industrial water, it is omitted from data tables because they only began reporting its use in 2018; therefore, there was no 2014 reported use to include with the other 2014 baseline data.

Irrigation Use

There are 172 wells classified as Irrigation use, producing 3.683 mgd within the Central ASEA, most from Kama`ole aquifer: 2.826 mgd. All surface water use diversions originate from outside the Central ASEA. End uses of surface water diversions are not generally qualified by use type. It's possible that some surface diverted through the Wailuku Water Company for irrigation purposes extend into the Central ASEA. Surface water diverted via the East Maui Irrigation System is used for agricultural and municipal uses. A small surface water diversion of 0.006 mgd within the Central ASEA is not qualified but assumed to be for agricultural or irrigation end uses.

Agricultural Use

Water from the Nā Wai `Ehā in the Wailuku ASEA and from East Maui Streams in the Ko`olau ASEA was transported to irrigate sugarcane on the central Maui isthmus, which has been grown continuously from the late 1800s until the closing of HC&S sugarcane operations at the end of 2016. The figure below illustrates agricultural crops and associated water use based on the 2015 Agricultural Baseline. Water duty is assigned in accordance with State Department of Agriculture Irrigation Water Use Guidelines.

[39] H.R.S. §174C-3

The 36,000 acre HC&S plantation is no longer cultivated in sugarcane as indicated in the figure below. A&B diversified agricultural operations recently began transition to new diversified agriculture activities: (1) livestock pastures – a 4,000-acre expansion of the previous 29 acres of pasture space for grass-fed beef ranching, which is a collaborative effort with Maui Cattle Company that will allow Maui ranchers to keep more beef in Hawaii to serve local markets; (2) Feedstock -- A 500-acre project including corn, sorghum, and soybeans to grow feedstock to be used at the Maui County Wailuku-Kahului Wastewater Treatment Plant; and (3) a 250-acre trial to study the viability of cultivating Pongamia as an energy crop. The biofuel project may expand up to 2,000 acres. The HC&S/A&B Inc.'s diversified agriculture plan and proposed irrigation needs are analyzed under future water use, chapter 15.6.

Figure 15-15 Central ASEA 2015 Agricultural Baseline Land Use

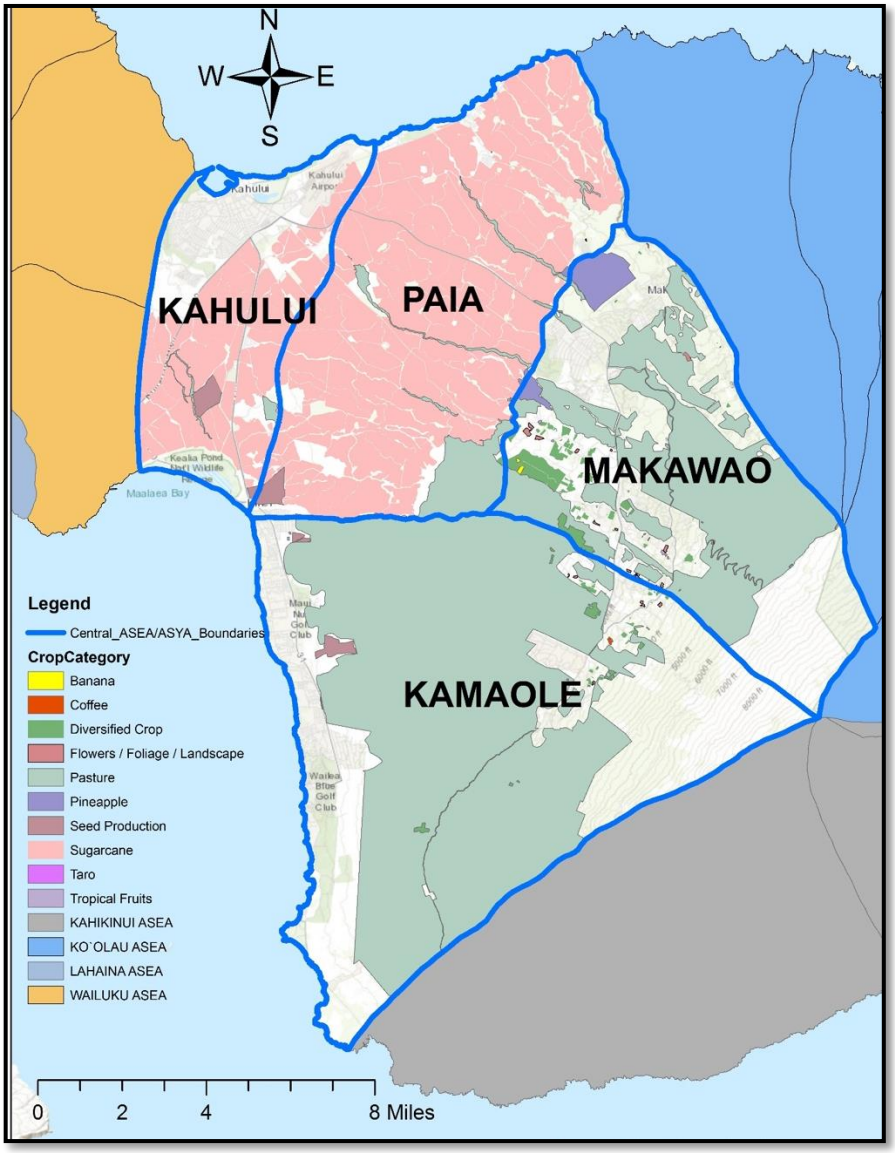


Table 15-5 Central ASEA Agricultural Water Demand (mgd), 2015 Agricultural Baseline

Crop	Acreage	Water Use Rate (gpd per acre)	Estimated Water Demand 2015 (mgd)
Banana	16.70	3,400	0.057
Coffee	10.58	2,900.00	0.031
Diversified Crop	1,197.22	3,400.00	4.071
Flowers / Foliage/ Landscape	97.97	4,000-6,000	0.490
Pasture	53,720.04	0-6,700	0.000
Pineapple	1,093.52	1,350.00	1.476
Seed Production	754.41	3,400.00	2.565
Taro	0.23	100,000-300,000*	0.035*
Tropical Fruits	21.69	4,400-10,000	0.156
Kula Agricultural Park	302.00 (usable)	*2	1.027*2
Kula Agricultural Park Expansion	742.00 (usable)	*3	2.523*3
CENTRAL Total	**57,929.08**		**12.431**

Water Use Rates - HDOA Guidelines
Coffee: 2004 AWUDP - 2500 gpd; however, 2900 gpd reported by plantation on Oahu per Brian Kau, HDOA, personal communication 10/12/2016.
Wetland taro: Per CWRM CC D&O, Nā Wai `Ehā and East Maui Streams
*Taro water use per acre is the middle point (150,000 gpd) of the range (100,000 gpd – 300,000 gpd) of water flow needed for taro—not consumption
*2 Kula Agricultural Park numbers based on actual use
*3 Estimated water demand for 860-acre planned future expansion of the current Kula Agricultural Park (360 acres) was calculated based on the present demand and ratio of usable area to unusable area of the presently operating Kula Agricultural Park, with an additional 10% more anticipated to be required, based on a lower elevation (1,075 feet--675 feet lower) and less precipitation.

Kalo Lo`i and Appurtenant Rights

The 2015 Statewide Agricultural Land Use Baseline indicates that about 0.23 acres are currently cultivated in taro within the Central ASEA. The consumptive use is not the stream flow required through the lo`i for healthy plants, but it is the plant use that is not returned to the stream, i.e. the lo`i kalo water lost through percolation, evaporation and evapotranspiration.

Municipal Use

Municipal use comprised 2.4 percent of reported groundwater pumpage within the Central ASEA. Residential and commercial uses comprise the majority of the Municipal use category. In

addition to the County Department of Water Supply (MDWS) there are five small privately owned "public water systems" as defined by the Department of Health (systems serving more than 25 people or 15 service connections). It is noted that Department of Health (DOH) identifies public water systems by source serving the system.

Table 15-6 Public Water Systems, Central ASEA

PWS No.	Name	Owner	Population Served	No. of Connections	Average Daily Flow (gpd)	Source
212	Wailuku/ Central System	MDWS	68,976	20,465	21,153,987	Ground/ Surface
215	Upper Kula/ Upcountry System	MDWS	7,038	2,346	19,611,000	Ground/ Surface
247	Lower Kula/ Upcountry System	MDWS	3,192	1,064	3,431,000	Surface
213	Makawao/ Upcountry System	MDWS	28,702	6,675	3,580,000	80% Surface/20% Ground
254	Maunaolu Plantation	Maunaolu Plantation Homeowners Association	100	39	200,000	Ground
255	Kula Nani	Kula Nani Estates Community Association	80	38	85,000	Surface (MDWS)
256	Maui Highlands	Highland Services, LLC	--	53	530,000	Ground
258	Consolidated Baseyards	Consolidated Baseyards Association	69	35	83,000	Ground
261	Maui Business Park	Maui Business Park Phase II Association, a subsidiary of Alexander & Baldwin, LLC	--	127	383,124	Pural Potable and Non-potable Ground

Source: State Dept. of Health, 2015 based on 2013 survey of water production submitted by providers every three year.

MDWS Wailuku District/Central System (PWS 212)

The MDWS Central System, also referred to as Wailuku District by the DOH, generally serves the area extending from Waihe`e to Pā`ia/Kuau on the north shore; Kahului, Wailuku and Waikapū on the Central isthmus; and from Ma`alaea to Mākena on the south shore. The sources of water are primarily from ground water pumped from the `Īao and Waihe`e aquifers supplemented with groundwater from Kahului Aquifer, surface water from the Wailuku River, and a production tunnel in `Īao Valley. The MDWS Central System is addressed in the Wailuku ASEA Report, with existing water use shown in Table 14-13 and the system distribution in Figure 14-18.

MDWS Upcountry System

The MDWS relies on three surface water sources, one of which is delivered by EMI through the Wailoa Ditch, and the other two through two MDWS higher elevation aqueducts maintained by EMI that transport water to Olinda and Kula, under a contractual agreement originated under the 1973 East Maui Water Agreement and subsequent agreements. MDWS and EMI diverts water from Ko`olau ASEA, conveyed to treatment plant facilities located in Ko'olau ASEA (Piiholo Water Treatment Facility) and the Central ASEA (Olinda and Kamole Weir Water Treatment Facilities). The Olinda facility diverts water at the upper Waikamoi Flume from the Waikamoi, Puohokamoa, and Haipuena Streams. Water is stored in two 15 million gallon reservoirs and one 100-million gallon reservoir. The Piiholo facility diverts water from the Waikamoi, Puohokamoa, Haipuena Streams and Honomanu streams into a 50-million gallon reservoir. The Kamole-Weir facility relies on EMI diversions from eastern most Makapipi stream to the western most Honopou stream.

The Upcountry system spans Ko`olau and Central aquifer sectors, as illustrated in the figure below, and serves about 35,200 people. MDWS also serves non potable water to 31 farm lots at the Kula Agricultural Park (KAP). Current water use at the KAP is about 0.4 mgd. About 80 – 90 percent of the delivered water comes from surface water sources and the remaining portion from basal aquifer wells. Haiku Well and Kaupakalua Well are located in the Ko`olau ASEA, Hamakuapoko Well 1 & 2 and Po`okela Well are located in the Central ASEA. The combined surface and groundwater source production capacity is 17.9 mgd, 13 mgd from surface water and 4.9 mgd from groundwater. Accounting for system and operational limitations, and use restrictions from Hamakuapoko wells, the reliable capacity is 9.1 mgd. Current water use averages 7.9 mgd within a range of 6 – 10 mgd.

The DOH divides the MDWS Upcountry System into three separate systems: Upper Kula; Lower Kula and the Makawao systems, although all three are interconnected.

MDWS Makawao/Upcountry Water System (PWS 213)

The MDWS Makawao/Upcountry System, also referred to as Makawao District by the DOH, generally serves the area extending from Ha`iku, Makawao, and Pukalani to Hali`imaile/Pā`ia. The system has 6,680 meters and serves about 28,702 people. The sources of water are primarily from surface water imported from East Maui (80%) and well water (20%) from the Haiku and Makawao aquifers. Surface water from the Wailoa Ditch, generated in the Ko`olau ASEA, is treated at the Kamole Water Treatment Facility (WTF). The facility uses micro-filtration technology and is the largest surface water treatment facility on Maui. It has four booster pumps to move water up to the 2,800 foot elevation, where it can be pumped to the highest service areas at 4,500 feet. Historically, the Kamole WTF is the primary source of water for nearly all of Upcountry during times of drought. There is no raw water storage at the WTF.

Two wells in the Haiku aquifer supplies most of the Haiku service area. The Haiku Well has detections of the contaminants 1,2-Dibromo-3-chloropropane (DBCP) and 1,2,3-Trichloropropane (TCP) at below allowable limits. Po`okela Well, with a backup well under development, withdraws water from the Makawao Aquifer. Two wells located in the Pā`ia Aquifer can supplement the Makawao system during drought. The Hamakuapoko wells are outfitted with granular activated carbon treatment technology to remove the chemical DBCP detected in the wells. All sources meet Safe Drinking Water standards.

MDWS Lower Kula/Upcountry Water System [PWS 247]

The MDWS Lower Kula/Upcountry System, also referred to as Lower Kula District by the DOH, generally serves the area extending from Kula Kai to Omaopio to mid and lower Kimo Drive areas. The system has 1,064 meters and serves about 3,192 people. The sources of water are primarily from surface water imported from East Maui treated at the Pi`iholo WTF. The facility uses direct filtration technology. Granular activated carbon and air stripping treatments were added in 2015 to reduce disinfection-byproducts in the water supply. The system can be supplemented with groundwater from Makawao aquifer.

MDWS Upper Kula/Upcountry Water System [PWS 215]

The MDWS Upper Kula/Upcountry System, also referred to as Upper Kula District by the DOH, generally serves the area extending from Upper Kula to Kula Highlands to Kama`ole to Upper Olinda-Piiholo to Kula Glen to Ulupalakua-Kanaio. The system has 2,346 meters and serves about 7,038 people. The source of water is primarily from surface water from Waikamoi treated at the Olinda WTF. The facility uses micro-filtration technology. Disinfection is provided by anhydrous ammonia, blended with chlorine to form chloramines. Water is stored in 30 MG Waikamoi Reservoirs and the 100 MG Kahakapao Reservoirs.

The Upcountry water treatment facilities, annual and average production is shown in the table below. 2014 is the base year for forecasting demand in this WUDP update. Demand varies annually due to multiple factors. 2014 was a relatively wet year but demand is comparable to water use over a 10-year period. Demand varies seasonally as shown by high and low month

average daily production. Typically, during drought conditions, average daily demand increases. The Upcountry system monthly variation was as high as 89 percent in 2014.

Table 15-7 MDWS Upcountry Water Treatment Facilities, Annual and Average Daily Production, Central ASEA

WTF	2014 YTD (1000 gal)	ADP (mgd)	High YTD Production 2012-2014 (1000 gal)	High Month ADP 2012-2014 (mgd)	% Variation High Yr ADP 2012-2014/ 2014 ADP (mgd)
Olinda	336.690	0.922	546.770	1.494	62.4%
Pi'iholo	1,044.967	2.863	1,265.306	3.457	21.1%
Kamole	674.200	1.847	881.770	2.409	30.8%

Source: MDWS.

YTP= Year Total Production; ADP= Average Daily Production. Olinda was offline in the last quarter of 2014. High ADP 2012-14 for the individual WTPs did not all occur in the same year.

Table 15-8 MDWS Upcountry System Production, 10-Year Daily Average, 2005-2014, Central ASEA (mgd)

Total Production			Groundwater			Surface Water		
Total Daily Ave	High Month Total	% High / Ave Month	Daily Ave	High Month	% High / Ave Month	Daily Ave	High Month	% High / Ave Month
7.61	10.36	36%	1.23	2.06	68%	6.38	8.79	38%

MDWS production, 2005-2014

The MDWS Central System and the MDWS Upcountry System are not interconnected. The figure below illustrates both distribution systems, general location of wells, ditches and water treatment facilities.

Figure 15-16 MDWS Central and Upcountry Systems and Infrastructure

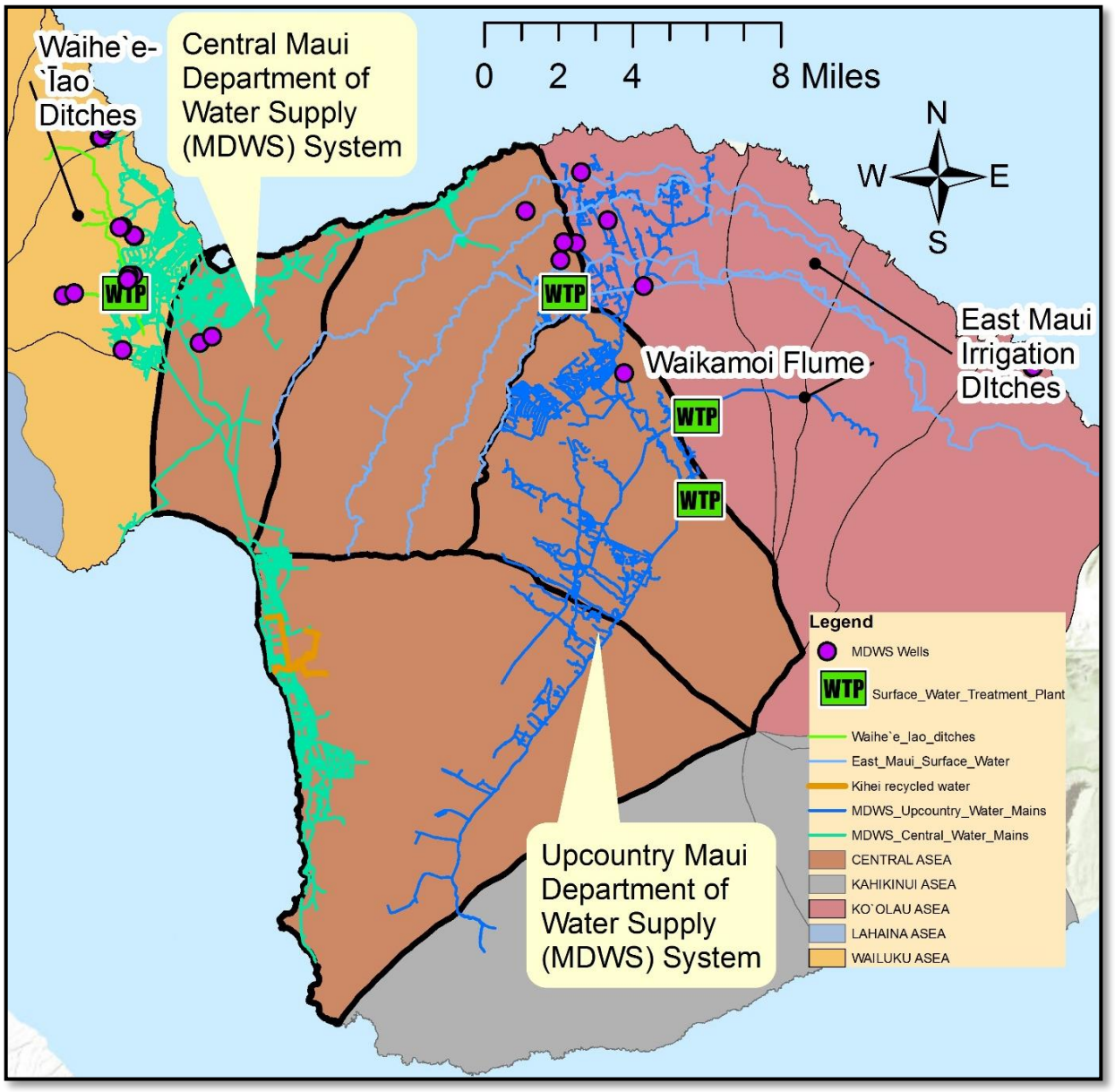


Table 15-19 MDWS Upcountry System (Including Kula Agricultural Park) Water Consumption by CWRM Category, 2014

DWS Upcountry System Total (without Kula Ag Park)	2014 (MGD)	2014 (GPD)	% of Total
Domestic Residential	4.8583	4,858,253	77.59%
Domestic Non-Residential	0.2412	241,212	3.85%
Industrial	0.0001	82	0.00%
Municipal	0.6051	605,061	9.66%
Agriculture	0.5367	536,687	8.57%
Irrigated	0.0010	991	0.02%
Military	0.0002	197	0.00%
Unknown	0.0190	18,958	0.30%
TOTAL	**6.2614**	**6,261,441**	**100.00%**

Table 15-10 MDWS Upcountry System (Including Kula Agricultural Park) Water Consumption by CWRM Category, 2014

DWS Upcountry System Total (with Kula Ag Park)	2014 (MGD)	2014 (GPD)	% of Total
Domestic Residential	5.1134	5,113,400	77.00%
Domestic Non-Residential	0.2449	244,940	3.69%
Industrial	0.0001	82	0.00%
Municipal	0.6051	605,061	9.11%
Agriculture	0.6569	656,896	9.89%
Irrigated	0.0010	991	0.01%
Military	0.0002	197	0.00%
Unknown	0.0190	18,958	0.29%
TOTAL	**6.6405**	**6,640,525**	**100.00%**

State Water Systems

A non-potable State water system exists within the Polipoli State Recreation area. The Polipoli Springs State Recreation Area water system is located in the Kahikinui Forest Reserve, overlying the Kama`ole Aquifer. The water system is owned and operated by the State of Hawai`i and managed by the DLNR-State Parks. The water system serves a park cabin and campground area. The non-potable source for the water system is an unnamed spring. The spring water flows through a 1-1/2-inch pipe to the campground area. The estimated water demand is 0.002 mgd. Information to determine the stream diversion capacity is not available and flow measurements

are not recorded. System source capacity adequacy could not be determined. Future water demands for the park are unknown.[40]

Federal Water Systems

There are no federal water systems within the Central ASEA.

Private Public Water Systems

Maunaolu Plantation: Pā`ia System of the Central Sector (PWS 254)

The Maunaolu Plantation Public Water System is owned by the Maunaolu Plantation Homeowners Association and operated by the Pural Water Company, serving approximately 100 people. The Average Daily Flow is 0.2 million gallons per day (mgd), serving 39 meters/service connections. Potable water for Maunaolu Plantation is supplied by basal groundwater obtained from deepwells drawing from the Pā`ia Aquifer. Water from the well is chlorinated to ensure that drinking water meets the Safe Drinking Water Regulations of the EPA and the Safe Drinking Water Branch of the Hawai`i Department of Health.

Water is stored in an 80,000 gallon steel tank. The average daily consumption per class of customer (Single Family) is 10,000 gpd. No future expansion is anticipated for the water system.

During a period from 2004 to 2009, one contaminant, Ethylene Dibromide (EDB), was found to exceed the legal limit. There have been no EPA violations reported for Public Water System 254 Maunaolu Plantation since 2004.[41]

Kula Nani: Kama`ole System of the Central Sector (PWS 255)

The Kula Nani Public Water System purchases surface water from the MDWS. It is owned by the Kula Nani Estates Community Association and maintained and operated by Pural Water Specialty Company. The system provides drinking and irrigation water to its approximately 80 customers on 38 service connections. Infrastructure includes two water storage tanks with a capacity to store a total of 0.085 mgd. The average daily consumption per class of customer (Single Family) in PWS 255 Kula Nani is 5,000 gpd. No future expansion is anticipated for the water system.[42]

Maui Highlands: Kama`ole System of the Central Sector (PWS 256)

The Maui Highlands Public Water System is owned by Highland Services, LLC, and operated by the Pural Water Company, serving approximately 53 service connections, stored in a 600,000

[40] State of Hawai`i, State Water Projects Plan, Volume 3, 2003.
[41] HI DOH SDWB; CWRM; Mr. Efren Ugalino; http://www.nps.gov/hale/planyourvisit/index.htm; http://www.ewg.org/tap-water/whatsinyourwater/HI/Maunaolu-Plantation/0000254/
[42]State of Hawai`i DOH SDWB; CWRM; Mr. Efren Ugalino; http://puralwater.com/

gallon steel tank. According to DOH, the Average Daily Flow (Single Family) is 10,000 gpd. Water is supplied by basal groundwater obtained from deep wells drawing from the Kama`ole Aquifer. Water from the two wells is chlorinated. No future expansion is anticipated for the water system.[43]

Consolidated Baseyards: Kahului System of the Central Sector (PWS 258)

The Consolidated Baseyards Public Water System is owned and operated by the Consolidated Baseyards Association, and serves 35 meters and approximately 69 people. According to DOH, the Average Daily Flow is 83,000 gpd. Potable water for Consolidated Baseyards is supplied by basal groundwater obtained from deep wells drawing from the Kahului Aquifer, and it is stored in a 350,000 gallon steel tank. Water from the wells is chlorinated. No future expansion is anticipated for the water system.[44]

Maui Business Park: Kahului System of the Central Sector (PWS 261)

The system is owned by the Maui Business Park Phase II Association, a subsidiary of Alexander & Baldwin, LLC. The 154-acre industrial-zoned land in central Kahului is in close proximity to Kahului Harbor and Airport.

Currently, service is provided to approximately 127 commercial customers, using an estimated 383,124 gpd, consisting of 258,795 gpd of non-potable water,[45] and 124,329 gpd of potable water.[46] Both potable and non-potable water are pumped from the Kahului Aquifer. Infrastructure construction is complete, and lots are for sale, varying in size from 0.5 - 20 acres. This is a dual water system supply, purchasing water from the Pural Water Specialty Company to provide drinking and irrigation water. Each lot has two water meters, one for potable and one for non-potable. The non-potable well is located in the vicinity of the Business Park, within the Kahului Aquifer. There is a monthly service fee, but no upfront fee for the meters. Water is chlorinated and stored in a 600,000 gallon glass-fused steel tank.[47] Future expansion is anticipated for the water system to accommodate the lots that are not metered at this time. There are no residential or heavy industrial water users.

Department of Hawaiian Homelands (DHHL)

DHHL lands are occupied by Native Hawaiians who are assumed to live the full-range of traditional Native Hawaiian cultural practices based on their ability to implement the knowledge of their heritage. Upcountry Maui (Kēōkea/Waiohuli, Ulupalakua, Kualapa) has over

[43] Ibid.
[44]State of Hawai`i DOH SDWB; CWRM; Mr. Efren Ugalino.
[45]State of Hawai`i Commission on Water Resource Management, Waiale 1 Well (Well Number 6-5129-004) and Waialae 2 Well (Well Number 6-5129-005), average pumpage October 1, 2011 to April 1, 2018.
[46]Ibid, MBPII Non-Potable (Well Number 6-5226-00) average pumpage, January 1, 2014 to April 1, 2018

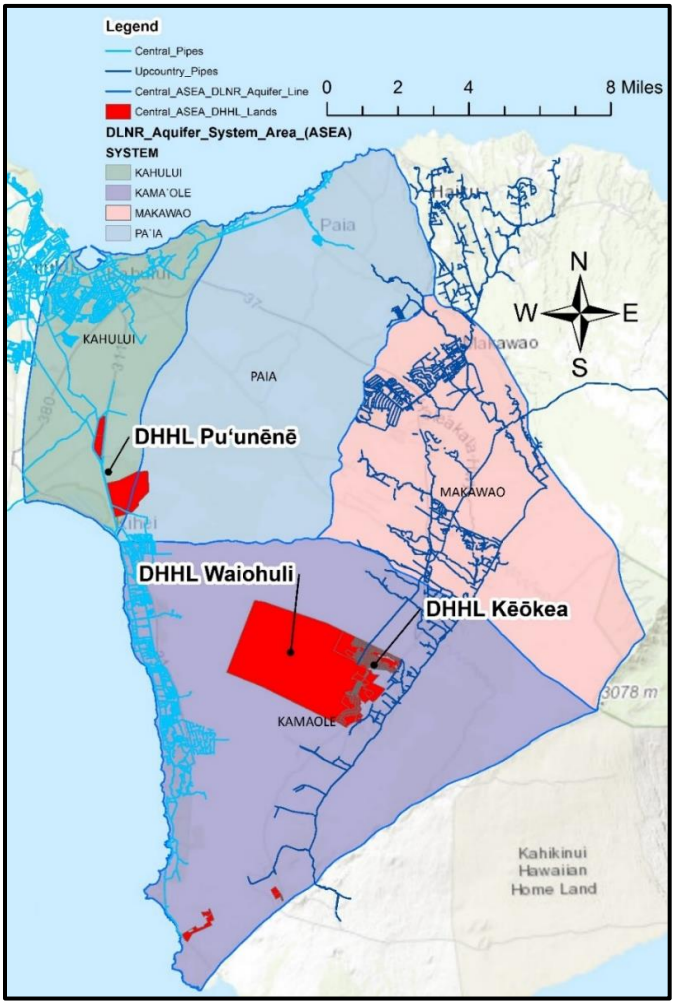
[47]Ibid; www.mauibusinesspark.com

6,000 acres of DHHL lands. The Makawao-Pukalani-Kula Community Plan section, "Identification of Major Problems and Opportunities of the Region Problems" cites "limited development of water resources and distribution system to meet the needs of the region as a primary concern," and notes that "The proper allocation of water resources is considered essential to encourage the development of Department of Hawaiian Home Lands (DHHL) parcel."[48]

The DHHL Maui Island Plan

The Hawaiian Homes Commission adopted its Maui Island Plan as the overarching planning document in 2004. The DHHL Central Maui planning region encompasses three large land tracts totaling 2,141 acres, and there are three major DHHL project areas in the Central ASEA (Pu`unēnē, Kēōkea, and Waiohuli). The tracts are within the Kīhei-Mākena Community Plan area (DHHL Pu`unēnē) and Makawao-Pukalani-Kula Community Plan area (DHHL Kēōkea and Waiohuli), and as indicated in the figure below, the DHHL Pu`unēnē lands are found both within the Kahului and the Pā`ia aquifers, while the DHHL Kēōkea and Waiohuli lands are located in the Makawao aquifer.

Figure 15-17 DHHL Projects, Central ASEA



[48]County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 12.

Kēōkea/Waiohuli – Priority Tract

There are existing homesteaders in Keokea, and with adequate water and funding, this area has the potential to be the largest homestead region on Maui.[49] Over 6,000 acres of DHHL land are located below Kula Highway on the slopes of Haleakala, but water commitments from the Department of Water Supply are a crucial factor in the next phase of development planning.

Kuleana Parcels

There are existing kuleana parcels located within the Waiohuli homestead; however, the term "kuleana" is used differently within the context of DHHL land grant recipients compared to the term's common use, which is synonymous with appurtenant water rights holders. In general, kuleana parcels were historically awarded in fee by the Hawaiian monarchy in mid-1800s. History notes that kuleana parcels have also been awarded by Konohiki (ali'i) to tenants. According to the GIS layer supplied by OHA, the only "kuleana" water rights parcel is located in Maliko Gulch/Stream (1.98 acres).

15.5.2 Water Use by Resource

Water use in 2014 totaled 219.97 mgd in the Central ASEA, with surface water accounting for 71.5 percent of the total. Since the cessation of sugarcane cultivation, reported surface water use is significantly less and further analyzed under Future Water Use.

Water Transport

Irrigation of large scale agriculture on the Central isthmus, primarily sugarcane until 2016, was supplied by surface water derived from outside the Central ASEA hydrologic units and recharges the underlying groundwater within the Central ASEA. This manmade recharge is not accounted for in establishing Sustainable Yield.

Groundwater from Wailuku ASEA is transported throughout the municipal Central Maui System/Wailuku District, serving population centers in the Central ASEA. Groundwater from `Īao and Waihe`e aquifers is mixed with groundwater from the Maui Lani wells in the Kahului Aquifer and surface water from the Wailuku River. Therefore, the exact amounts used within each aquifer sector cannot be determined. Surface water diverted from Nā Wai `Ehā was previously transported to the Central ASEA for sugar cane cultivation. One mgd is used for municipal uses.

Surface water from Ko`olau ASEA is conveyed through the East Maui Irrigation (EMI) System for irrigation of previous sugarcane cultivation. The MDWS purchases water from the Wailoa Ditch for municipal use Upcountry and non-potable water from Wailoa Ditch services the Kula Agricultural Park. The MDWS diverts surface water from Ko`olau ASEA at intakes above the EMI

[50] USGS Report 2008-5236, Groundwater Availability in the Wailuku Area, Maui, Hawai`i 2008

system for the Lower Kula and the Upper Kula systems. Estimated water transfers are shown below.

Table 15-11 Estimated Water Imports, Central ASEA

Water Resource	Central ASEA Imports from Wailuku ASEA	Central ASEA Import from Ko`olau ASEA	Total
Surface Water	16 - 18	121.765	139.765
Groundwater	15.7	0	15.7
Total:	**31.7 – 33.7**	**121.765**	**155.465**

Source: CWRM 2014 Well Pumpage and Diversion Data, MDWS 2014 Billing and Production; CCHMA 06-01-2 D&O. Smaller purveyors and end uses not shown.

Ground Water Resources

Most of the public water supply on Maui Island, including the Central ASEA, is derived from basal sources in the Wailuku ASEA. Groundwater from the Kahului, Kama`ole and Pā`ia aquifers are primarily used for non-potable purposes. Well development in the Makawao Aquifer is limited. The table below shows pumpage and pump capacity of installed wells, compared to sustainable yield. Pump capacity does not reflect permitted or actual pumpage, but the total capacity of installed pumps in gallons per minute, multiplied by 60 minutes, multiplied 24 hours, in order to determine how much water could be pumped if the well were in operation for a full day.

Table 15-12 Pumpage and Pump Capacity of Wells Compared to Sustainable Yield of Aquifers, Central ASEA

Aquifer System	Pumpage	Installed Pump Capacity	SY	Pumpage as % of SY
Kahului	30	102.12	1*	3000%
Pā`ia	29.51	153.73	7*	422%
Makawao	0.37	4.96	7*	5%
Kama`ole	2.85	18.83	11	26%
Total	62.72	279.64	**26**	**241%**

Source: CWRM Well Index 5/29/15 for production wells and 2014 pumpage reports, 12-month moving average
*Only basal water

Chloride Concentrations

Salinity of water withdrawn from wells in the aquifer sector generally increases with depth, proximity to the coast, and withdrawal rates. Before the addition of irrigation water from outside the Central isthmus, the Kahului Aquifer was believed to be naturally brackish. Many of the older high-capacity irrigation wells and shafts operated by sugarcane plantations in central Maui reported salinity exceeding 4 percent of seawater.[50] The influx of surface water from Nā Wai `Ehā and from East Maui for sugarcane irrigation contributed irrigation return recharge to

[50] USGS Report 2008-5236, Groundwater Availability in the Wailuku Area, Maui, Hawai`i 2008

augment the quality and quantity of the groundwater lens below. Generally, wells along the coast lines and areas of Kahului Aquifer are semi-brackish to brackish. The MDWS Maui Lani wells have experienced rising chloride levels, which can be due to concentrated pumpage from production wells that are located very close together and operated simultaneously rather than in rotation, or decreased recharge. When a well is pumping freshwater from an aquifer that consists of two sublayers (freshwater and saltwater), the interface between freshwater and saltwater will rise due to the drawdown at the free surface of freshwater.

Hawaiian Commercial and Sugar Company (HC&S) pumped brackish to semi-brackish water from the Kahului and Pā`ia aquifers for irrigation of sugarcane but also for industrial uses. Brackish groundwater pump capacity is 115 – 120 mgd. Pumpage for agricultural uses decreased from about 57 mgd in 2014 to 0.3 mgd in 2017. Decreased irrigation water return recharge over these aquifers have to date unknown impact on chloride levels. Increased chlorides in the Kahului and Pā`ia aquifers will likely also impact irrigation, municipal and other potable and non-potable wells.

In the long term, irrigation wells along the south shore in Kama`ole aquifer and along the north coast in Kahului and Pā`ia aquifers are potentially subject to rising sea-levels with associated seawater intrusion.

Impacts from Climate Change

The Central Aquifer Sector may be especially vulnerable to climate change impacts due to multiple factors:

1. The region hosts the bulk of population centers with growth regions and major infrastructure along the north and south shore coast lines, subject to sea-level rise.
2. Wells throughout Kahului, Paia and Kamaole aquifers are relatively shallow with potential impact from sea-level rise.
3. The dry micro-climates in Kahului and Kamaole aquifer systems have already seen a decrease in total rainfall.
4. Recharge under drought conditions are projected to be most severe for the aquifer system of Kamaole with a 51 percent decrease compared to normal rainfall conditions.

Surface Water Resources

There are 10 streams/springs in the Central ASEA shown in the table below. Waikapū Stream is the only Nā Wai `Ehā perennial stream that extends to the Central ASEA, but its lower reaches within the Central ASEA are usually dry. Surface water diversions constituted the majority of water diverted from Nā Wai `Ehā for agricultural purposes through 2016. An estimated 16 – 18 mgd of surface water used in the Central ASEA is imported from the Wailuku ASEA. An estimated 121 mgd used is imported from the Ko`olau ASEA. MDWS uses about 1 mgd of surface water from Wailuku River for municipal uses and between 5.6 – 7.4 mgd from the Ko`olau ASEA.

Table 15-13 Surface Water Diversions, Central ASEA (gpd)

Surface Water	Domestic	Industrial	Agriculture/Irrigation	Municipal	Military	Total
Waihou Spring	--	--	--	--	--	**--**
Waika`alu Spring	--	--	--	--	--	**--**
Waika`ahi Spring	--	--	--	--	--	**--**
Polipoli Spring	--	--	--	--	--	**--**
Maliko Stream*	--	--	6,904*	--	--	**6,904***
"Unnamed stream 1."*[2]	--	--	--	--	--	**--**
"Unnamed stream 2."*[3]	--	--	--	--	--	**--**
Total Diverted Surface Water	**--**	**--**	6,904*	**--**	**--**	**6,904***

*Stream diversion, pump from Maliko Stream. Declared Q was estimated from pump capacity and the total Q (diverted quantity) of 1.260 MGY (6,904 gpd) includes both diversions #6-5218-002D and 6-5218-003D.
*[2]Stream diversion, from unnamed stream. Diversion from Wai`ale Reservoir (74) to Waihe`e Ditch.
*[3]Spring diversion, pipe from unnamed stream and rights claim.

Alternative Water Resources

Rainwater Catchment

Rainfall averages 15 inches along the southern coastline on Haleakala, and it increases to 70 inches as one moves eastward and into higher elevations.[51] Rainfall catchment systems occur in the eastern part of the hydrologic unit, from Makawao and Olinda and also scattered throughout Kula. There is no official inventory of catchment systems but it is an important supplemental resource for non-potable purposes. Catchments systems using potable treatment technologies have been installed Upcountry due to water meter limitations imposed by the Upcountry Meter Priority List.

Recycled Wastewater

There is reclaimed wastewater treated and distributed within the Central ASEA. The State of Hawai`i defines R-1 water as the highest-quality recycled water; it has undergone filtration and disinfection to make it safe for use on lawns, golf courses, parks, and other areas used by people. R-2 recycled water can only be used under restricted circumstances where human contact is minimized. Wastewater generated within the Central ASEA is treated at the Kahului Wastewater Reclamation Facility (WWRF), east of Kahului Harbor, and the Kīhei WWRF. Both

[51] Johnson Engott, USGS, Spatially Distributed Groundwater Recharge Model, Maui 2014-5168, page 6.

facilities are described in the Wailuku ASEA Report, Chapter 14.5.1.

The Maui County Code was amended in 1996 requiring commercial properties (agricultural, commercial, public uses) within 100 feet of a Maui County R-1 water distribution system to connect within one year of recycled water availability and to utilize recycled water for irrigation purposes. The CWRM can also require dual water supply systems for new commercial and industrial developments in designated water management areas if a non-potable source of water is available.

The Department of Environmental Management's Wastewater Reclamation Division (WWRD) must fulfill R-1 water obligations for projects that are either: a(1 already utilizing R-1 water and will see increased use as projects build out; or (2)) projects that are in close proximity to the existing distribution system and will be connecting in the near future.

Kahului WWRF

The Kahului WWRF serves the Central Maui area from Waiehu to Kuau. The current dry weather flow capacity is 7.9 mgd and average dry weather flow is 4.4 mgd. Currently, all of the wastewater processed by the facility is treated to R-2 recycled water standards meaning that there are restrictions on its uses and applications. The volume of R-2 water reused from the facility ranges from 3 to 7% of the incoming wastewater flow. The daily average of R-2 water used is 0.2 mgd with most of the recycled water utilized within the facility for landscape irrigation and industrial uses. Some of the R-2 water is sold to construction companies that use it for dust control.[52]

Kīhei WWRF

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. The current dry weather flow capacity and R-1 production capacity is 8.0 mgd, and the average dry weather flow to the WWRF is 3.58 mgd. The volume reused R-1 water ranges from 20-52% of the incoming wastewater flow depending upon the time of the year. The South Maui distribution system provides R-1 water to 24 commercial properties in South Maui for landscape and agricultural irrigation, cooling, fire control, erosion and dust control, drinking water for cattle, and other uses. [53]

The volume of R-1 water reused is subject seasonal fluctuations. Generally, more water is used for irrigation in the dry summer and fall months. The highest average daily volume for peak season use was 1.75 mgd in August, 2008. The excess R-1 water that is currently available during peak demand months is about 1.39 mgd (3.14 mgd wastewater flow minus 1.75 mgd peak month use). The available volume will be less due to additional planned R-1 use at

[52] Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010

[53] Department of Environmental Management, Wastewater Reclamation Division, Department of Water Supply Water Resource Planning Division, South Maui R-1 Recycled Water Verification Study, December 2009

developing commercial properties located near the existing R-1 distribution system. As of 2016, the WWRF estimates 0.7 mgd excess R-1 supply is available. During winter months, wastewater flow rates to the WWRF typically increase due to greater visitor levels in South Maui while irrigation demands lessen and as a result excess R-1 water is available. Large irrigated areas are needed to utilize the seasonal excess water in winter months. However, in summer months there would unlikely be sufficient R-1 produced to meet irrigation demands for such large acreage, therefore requiring alternative sources as contingency.

Table 15-14 Wastewater Reclamation Facility Capacity, Production and Use, 2014 (mgd)

WWRF	Treatment Level	WWRF Design Capacity	Recycled Water Produced	Recycled Water Used	% of Total Produced Used	% of Design Capacity Used	Application
Wailuku-Kahului	R-2	7.9	4.7	0.25	5.3%	3.2%	None
Kīhei	R-1	8	3.6	1.5	41.5%	18.7%	Golf Course, Agriculture, Dust Control, Landscape, Fire Protection
Mākena (Private)	R-1	0.75	0.08	0.08	10.6%	10.6%	Golf Course

Source: Department of Environmental Management, Wastewater Reclamation Division, Central Maui Recycled Water Verification Study, December 2010

Mākena Resort Wastewater Reclamation System

The Mākena area is predominantly served by cesspools. There is no publicly owned treatment works operating in the area. Mākena Resort is served by a privately owned individual wastewater system with effluent treated to R-1 quality. The Mākena Wastewater Reclamation Facility encompasses an area of approximately 13 acres, mauka of the Mākena North Golf Course. The reclaimed water is pumped up to a larger reservoir within the golf course irrigation system, mixed with non-potable ground water from nearby wells, and used to irrigate portions of the North and South courses. Its average daily capacity is approximately 0.72 mgd and is designed to be expanded to 1.5 mgd in the future. The current average daily flow is approximately 80,000 gallons. The primary reuse is golf course irrigation. Additional reuse is for wastewater facility uses such as landscape irrigation, washdown and dilution water.

Stormwater Reuse

Capture and reuse of stormwater runoff is an under-utilized water resource that provides an opportunity to reduce reliance on groundwater and surface water for landscape irrigation, especially when incorporated into the design of development projects in order to minimize infrastructure costs. There is no reported stormwater reuse in the Central ASEA, although some development projects may have stormwater controls incorporated into project design to reduce runoff and its effects. The *Hawai'i Stormwater Reclamation Appraisal Report, 2005, and*

Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008, screened and identified four projects on Maui within the final ranking, which might provide opportunities to augment agricultural irrigation water that is diverted currently from Maui streams, in addition to providing other benefits:[54] The Wai`ale Road Stormwater Drainage option uses an existing stormwater drainage channel and detention pond located along Wai`ale Road to capture and convey stormwater into the Waihe`e and Spreckels Irrigation Ditch Systems for agricultural irrigation to the south and east.

Desalination

There are no desalination projects in the Central ASEA. Desalination of ocean or brackish water was explored by Brown & Caldwell as a supplemental option to the MDWS Central Maui system/Wailuku District with a long term goal to reduce draw on the ``Īao aquifer. An analysis targeting desalination treatment capacity of 5 mgd using reverse osmosis (RO) technology was completed for brackish and seawater alternatives. Both are technically feasible alternatives that meet current health standards and drinking water regulations. [55] Brackish water desalination appears economically feasible.

[54] Hawai'i Stormwater Reclamation Appraisal Report, 2005, and Study Element 3: An Appraisal of Stormwater Reclamation and Reuse Opportunities in Hawai'i, September 2008. http://files.Hawai'i.gov/dlnr/cwrm/planning/hsrar_element3.pdf

[55] Brown & Caldwell, 2006. County of Maui Department of Water Supply Central/South Maui Desalination Feasibility Study Final Report

15.6 Future Water Needs

15.6.1 General

Two alternative methods were used to project water demand to the year 2035: Population growth rates based on 20-year population growth projections in the Socio-Economic Forecast Report (2014) applied to current consumption and build-out of permitted land use based on County zoning and Department of Hawaiian Homelands land use plans. Population-based demand takes into account social and economic factors that are anticipated to drive growth over the planning period.

15.6.2 Water Use Unit Rates

Historically, most of the water use in the Central ASEA is for agricultural use, with residential or single-family use following. The 2002 Water Use Standards are used for land use based demand projections. The Water System Standard for residential use on Maui is 600 gallons per day (gpd) per unit and 3,000 gallons per acre. Future water demand is projected based on the standard of 3,000 gpd per acre for single family/duplex and 5,000 gpd per acre for multi-family use.

The Central Aquifer Sector Area (ASEA) encompasses about 229 square miles, including 4 groundwater aquifer system areas underlying the western flank of Haleakala Mountain: Kahului, Pā`ia, Makawao, and Kama`ole. The population of the Central ASEA includes parts of the resident populations from the following community plan areas: Kīhei-Mākena, Wailuku-Kahului, Makawao-Pukalani-Kula, Pā`ia-Ha`ikū. The estimated population of the Central ASEA was 103,970 in 2015 and is projected to increase by approximately 33 percent to 138,164 by 2035.

15.6.3 Land Use-Based Full Build-Out Water Demand Projections

Build-out of land use based on zoning designations represents a snapshot of ultimate demand. Since DHHL lands are not subject to County Zoning regulations, DHHL acreages are addressed separately based on the DHHL's Maui Island Plan and its regional plans. Full build-out projections for the Central ASEA area based on County zoning and DHHL land use categories yield a projected water demand of 427,000,241 gpd, or 427 million gallons per day (mgd). Full build-out by county zoning designation is not realistic over the 20-year planning period or supported by the County of Maui General Plan. The directed growth strategy in the General Plan provides the framework for future zoning changes.

About 78 percent of land in the Central ASEA is zoned Agriculture. System standard water rates for agricultural zoning are assigned but do not represent regional irrigation needs. Agricultural land include former irrigated sugarcane fields as well as unirrigated pasture along the leeward western flank of Haleakala. It should be noted that large scale agriculture has historically relied

on surface water for their irrigation needs and is not projected to be served by the municipal system or available groundwater in the Central ASEA.

Maui County Zoning

Maui County Zoning Districts are aggregated by land uses types with similar water use rates for the purpose of projecting potential full build-out water demand in the table below. Directed Growth Plan guidance and Community Plan designations were generally used for purposes of calculating water demand associated with Interim zoned lands. Interim and Project District-zoned land was assigned a zoning classification based on Directed Growth Plan guidance and Community Plan land use designations, in order to calculate water demand for these areas. There are over 142,173 zoned acres in the Central ASEA, excluding DHHL lands.

Table 15-15 Summary of Zoning and Community Plan Designation Types, Central ASEA (Excluding DHHL Lands)

Zoning Summary (Corresponding County Zoning Categories in Parentheses)	Acres	% of Total	Water Use Rates (gpd per acre)
SF Single Family Residential, Duplex, Residential (R-1, R-2, R-3, MRA), RU-0.5 Rural - 1/2 Acre, SBR Service Business Residential)	9,060.40	6.37%	3,000
Apartment (A-1 Apartment, A-2 Apartment), MRA Multi-Family Residential, MRA Business Multi Family	1,687.89	1.19%	5,000
Business (B-1 Business, B-2 Business, B-3 Business, BCT Business Country Town)	553.91	0.39%	6,000
Industrial (M-1 Light Industrial, M-2 Heavy Industrial)	1,316.38	0.93%	6,000
Hotel (BR Business – Resort)	537.11	0.38%	17,000
Agriculture (AG Agriculture)	110,780.01	77.92%	3,400
Golf Course (Park - Golf Course)	1,309.95	0.92%	1,700
P-1 Public/Quasi-Public MRA, Public, HD-3 Historic District 3	2,037.79	1.43%	1,700
PK Park	1,175.00	0.83%	1,700
Open Space (Conservation, Drainage, Open Space, OS-2 Open Space Active, OZ Open Zone, Proposed Road, Road, Unzoned Road, Beach Right of Way), Planting Buffer	13,714.77	9.65%	0
TOTAL excluding DHHL Lands	**142,173.21**	**100%**	

Zoning supplied by Maui County Planning Department, Long Range Division, May 2015.
Lands both zoned and CP-designated "Project District" were assigned to either single family or multi-family residential uses based on ratio of similar existing development projects' assignments per ASYA.

State Department of Hawaiian Home Lands (DHHL) Water Demand Projections

The DHHL maintains land use jurisdiction over Hawaiian Homes and is not subject to county zoning designations. Water rates used by the State Water Projects Plan Update, DHHL, May 2017, and projected demand based on the DHHL Maui Island and regional land use plans are described in the table below.

Table 15-16 DHHL Land Use, Central ASEA Acreage, and Water Standards for Maui

Land Use	Acres or Residential Units Central ASEA	Potable Water Standard	Non-potable (gal/acre)
Residential	1,286 ac: Kēōkea (386 units [66 Subsistence Agriculture 3-ac lots, 320 Residential 1-acre lots]), Waiohuli (768 units = 768 acres)	600 gal/unit	None
Subsistence Ag	100 ac: Kēōkea-Waiohuli (ranching/grazing)*	600 gal/unit	3400 gal/acre
Supplemental Agriculture	0	None	3400 gal/acre
Pastoral	0	600 gal/unit	20 gal/acre
General Ag	546 ac: Pu`unene	None	3400 gal/acre
Special District		Varies	Varies
Community Use acres	109 ac: Kēōkea (69 ac) + Waiohuli (40 ac)	1,700 gal/acre or 60 gal/student	None
Conservation	0	None	None
Commercial	0	3,000 gal/acre	None
Industrial	100 ac: Pu`unene	6,000 gal/acre	None

Table prepared by MDWS, Water Resources & Planning Division. Figures are estimates based on DHHL Maui Island Plan and Regional Plans.

*State of Hawaii, Department of Hawaiian Homelands, Kēōkea-Waiohuli DHHL Regional Plan, 2011, page 18

The 2017 State Water Projects Plan (SWPP) has been updated to address DHHL's project needs from 2016 to 2031.[56] There are three major DHHL project areas in the Central ASEA (Pu`unene, Kēōkea, and Waiohuli). Planned projects by aquifer system area are summarized below. Projected water demand and strategies for build-out of the Central ASEA DHHL projects over the WUDP planning period are discussed below. Build out of the two projects are not included in directed growth areas, or appear accounted for in the MIP. Therefore, projected demand based on land use designations are added to the population growth-based forecast of water use for this aquifer sector.

[56] State of Hawai`i Department of Hawaiian Homelands, State Water Projects Plan Update, 2017

Table 15-17 DHHL Projects and Planned Land Use by Aquifer System, Central ASEA

Aquifer System	DHHL Project	Total Acres	Community Acres	Industrial Acres	Agricultural Acres	Residential Acres
Kama`ole	Kēōkea/Waiohuli	1,495	109	0	100*	1,286
Central	Puʻunēnē	646	0	100	546	0

*State of Hawai`i, Department of Hawaiian Homelands, Kēōkea-Waiohuli DHHL Regional Plan, 2011, page 18.

Kēōkea/Waiohuli

Kēōkea/Waiohuli is a large mixed use tract. The future Residential, Subsistence Agricultural and Community Use land use areas which will require water are limited to the mauka half of the tract in the SWPP time frame. The remaining 768 proposed Residential units and approximately 40 acres of Community Use which will be located below the 2,400-foot elevation will require a new water system. According to the SWPP, an exploratory well at the 1,900-foot elevation of the Waiohuli tract located water at approximately six feet above sea level. The water will need to be pumped from the wells to a reservoir which will service the higher elevations, and then will flow by gravity to the remainder of the service area. A second reservoir and a series of Pressure Reducing Valves (PRVs) will also be required.

The SWPP states that non-potable water will be required for irrigation of the Subsistence Agriculture lands, which could be supplied by the Upcountry Maui Irrigation System. The U.S. Department of Agriculture (USDA), National Resource Conservation Service (NRCS), is in the process of constructing this agricultural water system to supply untreated irrigation water from the Kahakapao Reservoir to farmers in the Upper Kula area, which will be operated by MDWS. The 1997 Final Watershed Plan Environmental Impact Statement indicated that there would be nine lateral systems supplied by the main pipeline, including the DHHL Kēōkea area. Due to budgetary considerations, DOA has indicated that they do not have any plans to construct the lateral to service the Kēōkea area, but that DHHL could construct this lateral at its own cost. Nevertheless, it is expected that the DHHL demands will be reflected in the upcoming Agricultural WUDP update. The USDA indicated that the current supply of water from MDWS may not be adequate to even service the proposed project area identified in the 1997 watershed plan. The DHHL recommends a coordinated effort be undertaken between DHHL, DOA and MDWS to determine the feasibility of utilizing the Upcountry Maui Irrigation System to supply the non-potable demands and, if so, to ensure that costs of the Kēōkea lateral are reflected in the AWUDP.

DHHL has a 1997 Water Credits Agreement with MDWS for 0.5 MGD of potable water for homesteading use in exchange for DHHL improvements to the water system. The agreement stipulates that MDWS shall not impose any time limitations on DHHL to draw or use the reservation. Two existing developments, the 321-unit Kula Unit 1, and the 44-unit Hikina infill

developments already used 0.219 MGD of the water credits, leaving a remaining balance of 0.281 mgd for future use. The Kēōkea Phase 1-4 project proposes a total potable demand of 0.809 mgd and non-potable demand is 0.578 mgd exceeding remaining credits.

The Waiahuli Project will be located below the 2,400-foot elevation and will require a new water system. The exploratory well at the 1,900-foot elevation of the Waiohuli tract is a feasible option should the Upcountry Irrigation System not be funded to serve non potable demand.

Pu`unēnē

Pu`unēnē tract consists of Industrial and General Agriculture land use areas located within the Kahului Aquifer System Area, which has a sustainable yield of 1 MGD. Water demand for the 100 acres of industrial use is approximately 0.6 mgd. There is a 36-inch MDWS Central Maui transmission main that runs alongside the tract which supplies potable water to Kīhei; however, the sources that supply this transmission main are limited. The DHHL MIP indicates that there are two abandoned brackish wells in the vicinity that would be acceptable for irrigation use. Funds have been appropriated for the development of a comprehensive water and wastewater master plan for the Pulehunui area in central Maui, which includes the DHHL Pu`unēnē tract. The master plan will be a collaborative effort between DHHL, DLNR, the Department of Public Safety and the Department of Accounting and General Services. At the time of the SWPP update, DHHL had developed a matrix of potential water servicing alternatives, which included options such as collaboration with multiple agencies, water conservation, and water reuse.

The remaining 546 acres would be set aside for general agricultural use with the opportunity to continue the existing sugar cane lease with HC&S.[57] However, the HC&S 2017 Diversified Ag Plan does not indicate any proposed use for the 546 acres. The uncertainty of HC&S lease prospects and the viability of groundwater from the Kahului aquifer needs to be further assessed. According to the SWPP water resource strategies need to be determined.

Other Central Aquifer Sector Tracts

There is a small DHHL land holding in Ulupalakua with a projected potable demand of 0.0034 mgd. Source strategy has not been identified. Kualapa and Kalihi/Kanahena lands overlying the Kama`ole aquifer have no projected water demand.

[57] DHHL Maui Island Plan, page 4-19

Table 15-18 Projected Water Demands and Strategies for DHHL Projects, Central ASEA, 2035 (mgd)

Sector/ System	Project	Potable (mgd)	Potable Strategy	Non-potable (mgd)	Non-potable Strategy
Central/ Kahului	Pu'unene	1.734	To be determined. Potential transport from Kama`ole to Kahului Aquifer	1.8564	To be determined
Central/ Kama`ole	Kēōkea/ Waiohuli	0.8097	Water Credit Agreement MDWS (0.2810) (Upcountry), New State System (0.5287)	0.578	Upcountry Maui Irrigation System
Central/ Kama`ole	Ulapalakua	0.0034	Coordinate with MDWS (Upcountry) – source not identified	0	
Total		**2.5471**		**2.4344**	

State Water Projects Plan, DHHL, May 2017 Final Report

Table 15-19 DHHL Potable and Non-Potable Demands by CWRM Water Use Category

		2031	**Cumulative**	**Demand by**	**CWRM Water**	**Water Use**	**Category (MGD)**
Primary Use	**Domestic**	**Industrial**	**Irrigation**	**Agriculture**	**Military**	**Municipal**	**Total**
Potable (for water development?)	0.063	1.824	0.000	0.000	0.000	1.634	3.521
Non-Potable for Water Development	0.000	0.000	0.000	11.652	0.000	0.000	11.652
Non-Potable	0.000	0.000	0.000	27.557	0.000	0.000	27.557
Total for Water Development	0.063	1.824	0.000	11.652	0.000	1.634	15.173
Total	**0.063**	**1.824**	**0.000**	**39.209**	**0.000**	**1.634**	**31.078**

The Makawao-Pukalani-Kula Community Plan calls for the MDWS to expand water supply and distribution systems, including catchment systems, in accordance with the directions set forth in the Plan. It also seeks to restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use; and to recognize and support the immediate allocation of water resources for Department of Hawaiian Home Lands projects and agriculture.[58] The Community plan also calls for an increase in the deliverable capacity of the Lower Kula line to 7.5 mgd and to extend the

[58] County of Maui, Makawao-Pukalani-Kula Community Plan, 1996, page 36.

line to Kēōkea to serve Department of Hawaiian Home Lands projects.[59] The following table summarizes County and DHHL land use/zoning based demand.

Table 15-20 Full Build-Out Water Demand Projections by CWRM Use Type, Central ASEA

CWRM USE CATEGORY		CWRM Land Use Category Based		DHHL Land Use Category Based				Total Proj. Demand (MGD)	
	Acres	Water Use Rate (gpd)	Proj. Demand (gpd)	DHHL Land Use	Acres / Residential Units	Water Use Rate (gpd)	Proj. Demand (gpd)		
Domestic Residential	10,748.29	3,000-5,000*	28,562,900	Residential	1,286 acres, Kēōkea (386 units), Waiohuli (768 units)	600 gal/unit	692,400	**29,255,300**	
Domestic Non-residential	1,091.03	6,000 gal/ac (Business) or 17,000 gal/ac (Resort)	12,454,330	Commercial	0	3,000 gal/acre	0	**12,454,330**	
Industrial	1,316.38	6,000 gal/ac	7,898,280	Industrial	100	6,000 gal/acre	600,000	**8,498,280**	
Agriculture	110,781.01	3,400 gal/ac	376,655,437	Agriculture	546*	3,400 gal/acre	2,533,000	**379,188,437**	
Open Space	13,714.77	0	0	Open Space	100	0	0	**13,714.77**	
Irrigation	1,309.95	1,700	2,226,915	N/A	N/A	N/A	0	**2,226,915**	
Municipal	3,212.79	1,700 gal/ac	5,461,743	Community	109	1,700 gal/acre	185,300	**5,647,043**	
Military	0	N/A	0	N/A	N/A	N/A		**0**	
TOTAL		**N/A**	**433,259,605**	**N/A**	**1,286 ac/1,154 units**	**N/A**	**4,010,700**	**437,270,305**	

Water demand calculation is minus 100 acres for non-irrigated pasture; 151.14 acres in south Maui parcels not included because not mentioned in the 2017 SWPP DHHL update

[59] Ibid, page 37.

State Water Projects Plan (SWPP) Water Demand Projections

The land use based projections are compared to those in the State Water Projects Plan, which projects future water demand to 2020. The SWPP states that, in general, new housing developments, agriculture irrigation projects, major facilities or major expansions were considered as having a significant impact on water resources. The SWPP was updated in 2017 for DHHL projects only, and therefore DHHL projects are not addressed in the summary below.

Table 15-21 SWPP Projected Water Demands, Central ASEA (mgd)

2020 Potable Demand	2020 Non-potable Demand	2020 Total Demand	Unmet Needs to be Met by MDWS	Projects with New State Water System	Non-potable Demand to be Met by Potable Sources
0.812	9.947	10.759	4.759	6.000	0.034

State Water Projects Plan, Hawai'i Water Plan, Volume 4, SWPP for Islands of Lanai/Maui/Moloka'i, 2003. DHHL Water Demands totaling 6.4484 mgd are excluded. Projects with New State Water System- Lower Kula Watershed Project. (DHHL Maui Island Plan Development 07082015.xlsx)

State projects include the Upcountry Irrigation Project which is tabled for the time being, and the Lower Kula Watershed Project. These are source transmission and development rather than end use demand. Many projects identified for the Central ASEA in the 2003 SWPP have been developed over the last 15 years. State projects that are assumed to add demand over the WUDP planning period are summarized in the table below. These projects include school and community center development which are assumed to be accounted for in the socio-economic forecast. No adjustments are therefore made to population growth based demand through 2035.

Table 15-22 SWPP Projected Water Demands Unmet Needs 2018 - 2035, Central ASEA (mgd)

2020 Potable Demand	2020 Non-potable Demand	2020 Total Demand
0.174	0.005	0.179

Agricultural Water Use and Development Plan (AWUDP)

The State Department of Agriculture oversees and promotes diversified agriculture and state-owned irrigation systems. The 2004 Agricultural Water Use and Development Plan (AWUDP) projects demand to 2020 on lands served by major irrigation systems which include the East Maui and Upcountry Maui Irrigation Systems. The AWUDP projected an increased water demand of 3 to 12 mgd on 891 to 3,544 acres of agricultural expansion based on a water use rate of 3,400 gpd per acre (which does not include irrigation system water losses). The projection was based upon population growth, partial replacement of imported produce with locally grown produce, and maintaining farm value growth in diversified agriculture.

Table 15-23 AWUDP Water Demand Forecast for Diversified Agriculture, Central ASEA 2001-2021

Irrigation System	Total Acres	Acreage in Use		Unused Acreage Remaining Available	Acreage Forecast for Diversified Agriculture		Forecasted Water Demand (mgd)	
		Estimated Percent	Acres		Worst Case	Best Case	Worst Case	Best Case
Upcountry	1,751	no data	no data	0	55	142	0.19	0.48

Compiled by MDWS based on AWUDP, 2003, revised 2004, Table 6b and 7d

More current data is available to project agricultural irrigation needs. No adjustments are done using the 2004 AWUDP.

The 2004 AWUDP also assessed the Upcountry Maui Irrigation System proposed for development by Hawaii Department of Agriculture, MDWS, the U.S. Department of Agriculture Natural Resources Conservation Services, and the Olinda-Kula Soil and Water Conservation District. The project, also known as the Upcountry Maui Watershed Plan, proposed to install a separate agricultural water distribution system to supply untreated water for irrigation purposes to farmers in the Upper Kula area. The water source, Kahakapao Reservoir is by definition not a source, but the same storage of Ko`olau diverted stream water that currently supplies the MDWS Upper Kula potable system. In October 2017, the project sponsors determined to discontinue construction, based on economics, project timeline and federal requirements.[60]

15.6.4 Population Growth Based Water Demand Projections (20-Year)

Population growth rate projections were applied in 5-year increments over the 20-year planning period from 2015 to 2035 for high, medium (base case) and low growth scenarios. Water consumption, including both public and private water systems, are compared to the incremental water needs for the next 20 years based on the *Socio-Economic Forecast Report, 2014* prepared by the Planning Department consistent with the Maui Island Plan. Water consumption and demand based on population growth rates do not account for large-scale agricultural irrigation needs. It was assumed that population growth, and thus water use, from the projects projected since 2017 in the State Water Projects Plan, excluding DHHL, are already accounted for by the population projections. DHHL projects are added to population growth based demand.

Most of the growth in the Central ASEA is projected within the designated urban and rural growth areas in Kahului, Pā`ia, Kihei and Wailea, Makawao, Pukalani and Kula.
Growth rates vary significantly between the Community Plan (CP) districts that make up the Central ASEA. Future growth rates in the districts are shown below. Applying the appropriate

[60] 10/4/17 USDA Soil & Water Conservation District letter

community plan growth rate for each MDWS subdistrict generates an average growth rate applicable to the water systems as a whole shown in the table below.

An average growth rate for the Central ASEA in general was calculated based on the portions of the hydrologic unit located in each community plan district. The average growth rate is applied to Domestic, Industrial and Irrigation uses that are not served by the MDWS systems.

Table 15.24 Historical and Projected Population to 2035, Wailuku-Kahului, Kīhei-Mākena and Makawao-Pukalani-Kula Community Plan Regions and Projected Growth Rates (Central ASEA)

COMMUNITY PLAN AREA	2000	2010	2015	2020	2025	2030	2035
Wailuku-Kahului	41,503	54,433	60,336	62,102	64,188	65,734	67,986
Percent Increase		31.15%	10.84%	2.37%	3.36%	2.41%	3.31%
Kīhei-Mākena	22,870	27,244	29,599	34,757	39,975	46,370	52,044
Percent Increase		19.13%	8.64%	17.42%	15.01%	15.99%	10.90%
Makawao-Pukalani-Kula	21,571	25,198	26,551	28,438	28,949	29,482	29,852
Percent Increase		16.81%	5.37%	7.11%	1.80%	1.84%	1.26%
Pā`ia-Ha`ikū	11,866	13,122	13,820	13,949	14,045	14,139	14,153
Percent Increase		10.58%	5.32%	0.93%	0.69%	0.67%	0.10%
MDWS Central System Growth Rate			1.91%	11.45%	10.58%	11.17%	9.35%
MDWS Upcountry System Growth Rate			1.09%	6.01%	1.68%	1.69%	1.2%
Central ASEA Average Growth Rate			1.682%	2.222%	10.146%	10.938%	8.923%

Source: Population Forecast: 2014 Socio-Economic Forecast, Maui County Planning Department, Long Range Planning Division, Water Demand: MDWS, Water Resources & Planning.

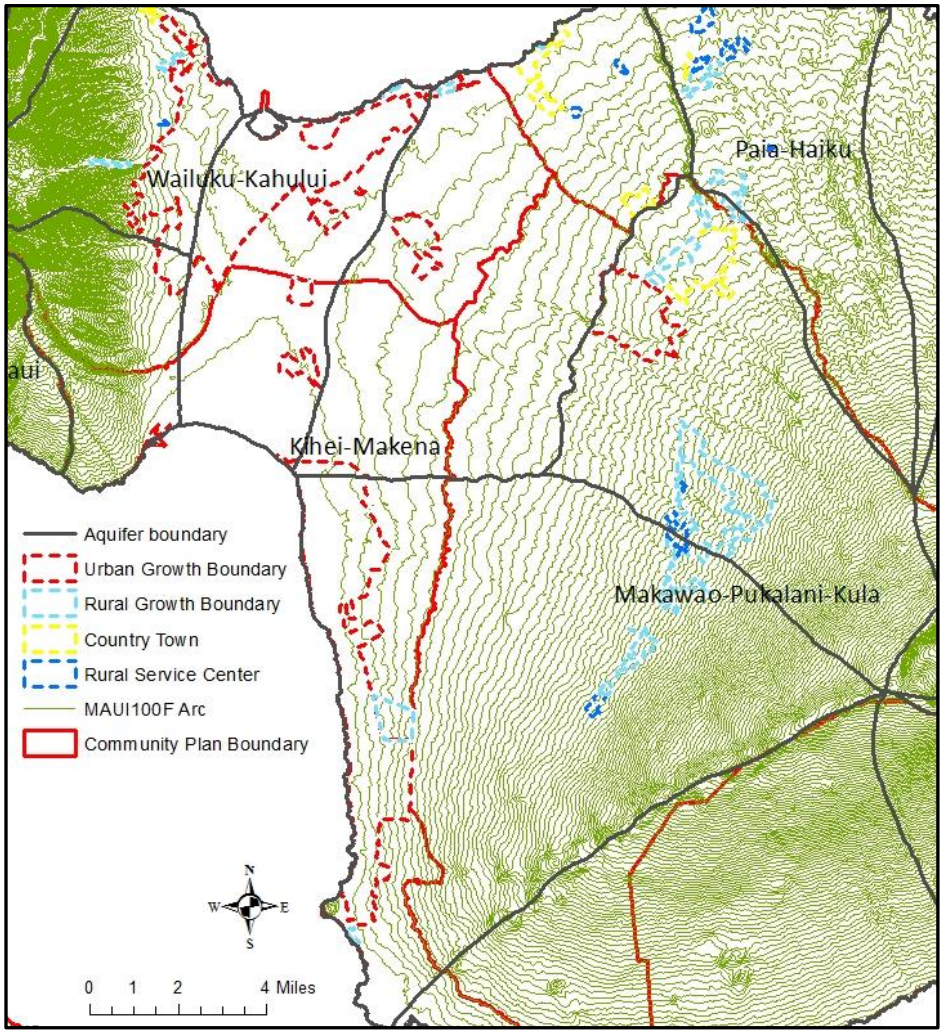
The table above represents base, or mid-growth rates. Low and high growth rates of -8.55 percent and +7.88 percent respectively are based on the 2014 Socio-Economic Forecast and calculated for Domestic, Irrigation, Industrial and Municipal uses in Table 15-34.

Population Growth Based Demand in Planned Growth Areas

The Directed Growth Plan was adopted as the primary purpose of the MIP to accommodate population and employment growth in a manner that is fiscally prudent, safeguards the island's natural and cultural resources, enhances the built environment, and preserves land use opportunities for future generations. The Directed Growth Plan establishes the location of future development and provides a framework for future community plan and zoning

changes and guides the development of the county's short-term and long-term capital improvement plan budgets.[61] Projected population growth and housing demand is concentrated to the Kahului and Kihei regions. Hydrologic units are interconnected when water is conveyed from high yield watersheds and aquifers to population centers and planned growth areas. Natural groundwater flow connects land use boundaries as water generally flows mauka to makai with the hydraulic gradient matching ground elevations. Groundwater flows from the Makawao-Pukalani-Kula Community Plan district towards the ocean in the Community Plan districts below. Water sources in high yield aquifers and watersheds are needed to supply population growth throughout Central and South Maui.

Figure 15-18 Community Plan Districts, Aquifer Boundaries and Elevation, Central ASEA



Projected water imports from the Wailuku ASEA resources through the MDWS Central System as a whole was addressed in the Wailuku ASEA Chapter 14.6. Water imports from the Ko`olau ASEA to the MDWS Upcountry system is addressed in this Sector under *MDWS Water Demand Projections*.

[61] Maui County General Plan 2030, Maui Island Plan page 8-2

Planned growth areas span the aquifer sectors of Wailuku, Central and Ko'olau. Growth areas most likely served by the resources within the Wailuku ASEA and the MDWS Central System was addressed in the Wailuku ASEA Report. These include planned growth areas in Wailuku-Kahului: Wai`ale, Pu`unani, Kāhili Rural Residential and Waikapū Tropical Plantation Town; Kihei-Makena region: Kihei Infill, North Kihei Residential, Kihei Mauka, Maui Research and Technology Park, and Pulehunui. Two projects would potentially be served by groundwater within the Central ASEA:

1) Wai`ale mixed-use town development is the largest proposed town on the island, with an estimated demand of 1.4 – 1.52 mgd. The on-site Wai`ale wells are developed in the Kahului aquifer. Alternative sources may be groundwater from the Waikapu aquifer.
2) Pulehunui planned growth area encompasses 639 acres primarily slated for industrial, public/quasi-public, and recreational purposes. There is limited MDWS infrastructure serving the area while private wells in Kahului aquifer serve industrial and non-potable uses. Source to supply up to 3.8 mgd would need to be identified.

Planned protected areas within the same regions were addressed in the Wailuku ASEA report as well. Two planned protected areas are located within the Central ASEA: the Makena-La Perouse-Kanaio Protected Area and the Kealia National Wildlife Refuge, shown in Figure 14-26. As noted in Chapter 14.6.4, the wildlife refuge benefits from recharge by Waikapu Stream in the Wailuku ASEA. Stream restorations in Waikapu have resulted in noticeably more water recharge to Kealia Pond.

Makawao-Pukalani-Kula

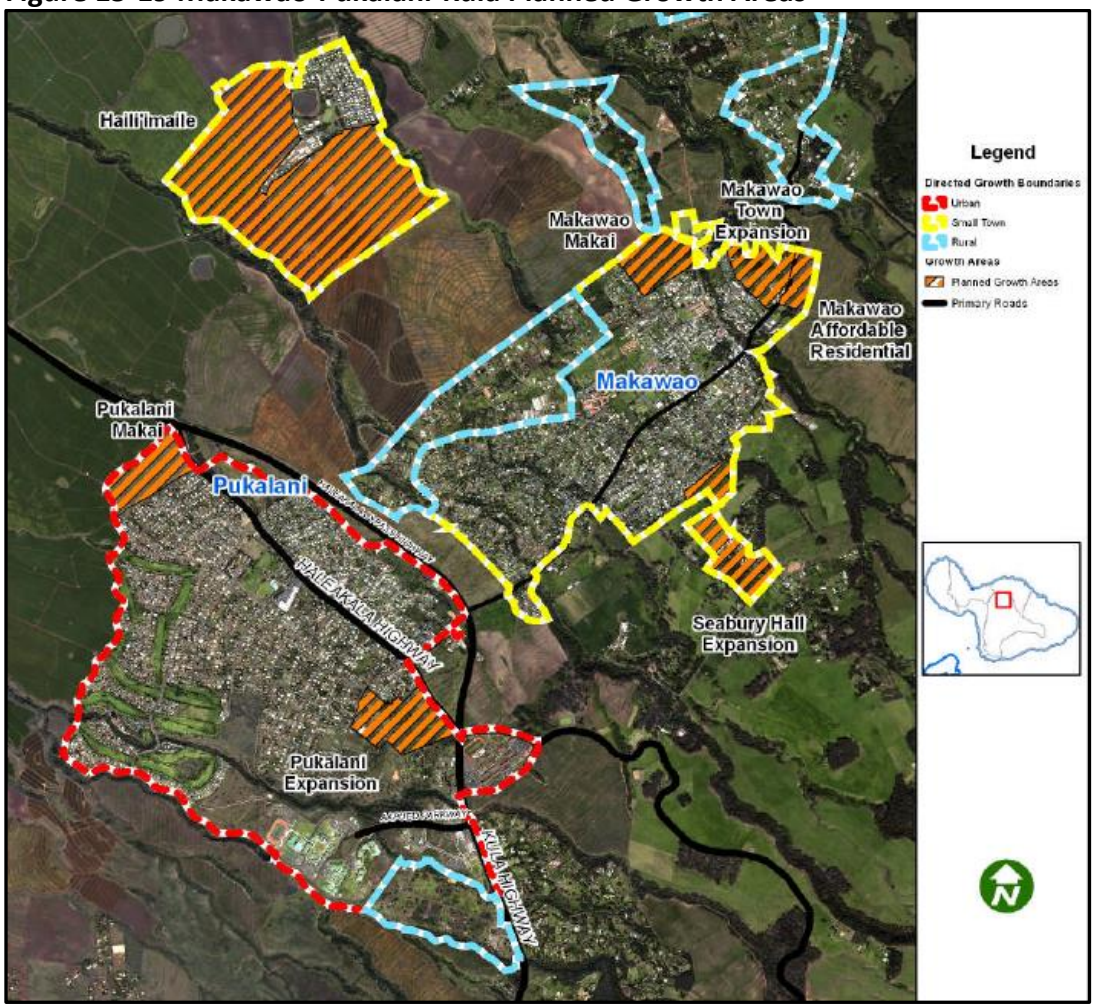
Makawao-Pukalani-Kula community plan region, also commonly referred to as Upcountry, is characterized by abundant open space, agricultural lands and rural towns. Nine planned growth areas are identified:

- Makawao Makai is a 39-acre expansion south of Makawao Veterans Cemetery on former pineapple fields.
- Makawao Town Expansion provides about 38 additional acres of town development.
- Makawao Affordable Residential, mauka of Makawao Avenue would provide affordable housing with no defined acreage or units to be developed.
- Seabury Hall planned growth area would add 68 acres for gradual expansion on land owned by Seabury Hall.
- Pukalani Expansion would be primarily residential development with neighborhood parks and a small commercial component.
- Pukalani Makai encompasses 45 acres of vacant agricultural land and would allow about 250 single family dwellings.
- Haliimaile planned growth area comprises 330 acres mauka and makai of Haliimaile Road. About 825 single family units would be developed as a range of affordable housing types.

- Anuhea Place is a planned rural growth area makai of Kula Highway and would provide 15 lots at 5 acres each.
- Ulupalakua Ranch planned rural growth area is intended to identify the boundaries of the ranch employee housing and provide opportunities for limited expansion.

All planned growth areas could potentially be serviced by the MDWS Upcountry System. New water source development and storage are recommended regional facilities. Projected demand for planned growth to meet population and housing needs in the designated growth areas is summarized in the table below.

Figure 15-19 Makawao-Pukalani-Kula Planned Growth Areas



Source: Maui Island Plan

Table 15-25 Planned Growth Central ASEA and MDWS Upcountry System Service Area

Planned Growth Area	# Units	# Acres	Projected Demand (mgd)
Makawao Makai	90	39	0.054 – 0.117
Makawao Town Expansion		38	0.228
Makawao Affordable Residential	N/A	N/A	
Seabury Hall		68	0.115
Pukalani Expansion	311	56	0.168 – 0.186
Pukalani Makai	250	45	0.135 – 0.150
Haliimaile	825	330	0.495 - 0.990
Anuhea Place	15	111	0.009 - 0.333
Ulupalakua Ranch	N/A	223	0.669
Total:	**1491**	**910**	**0.894 – 2.755 MGD**

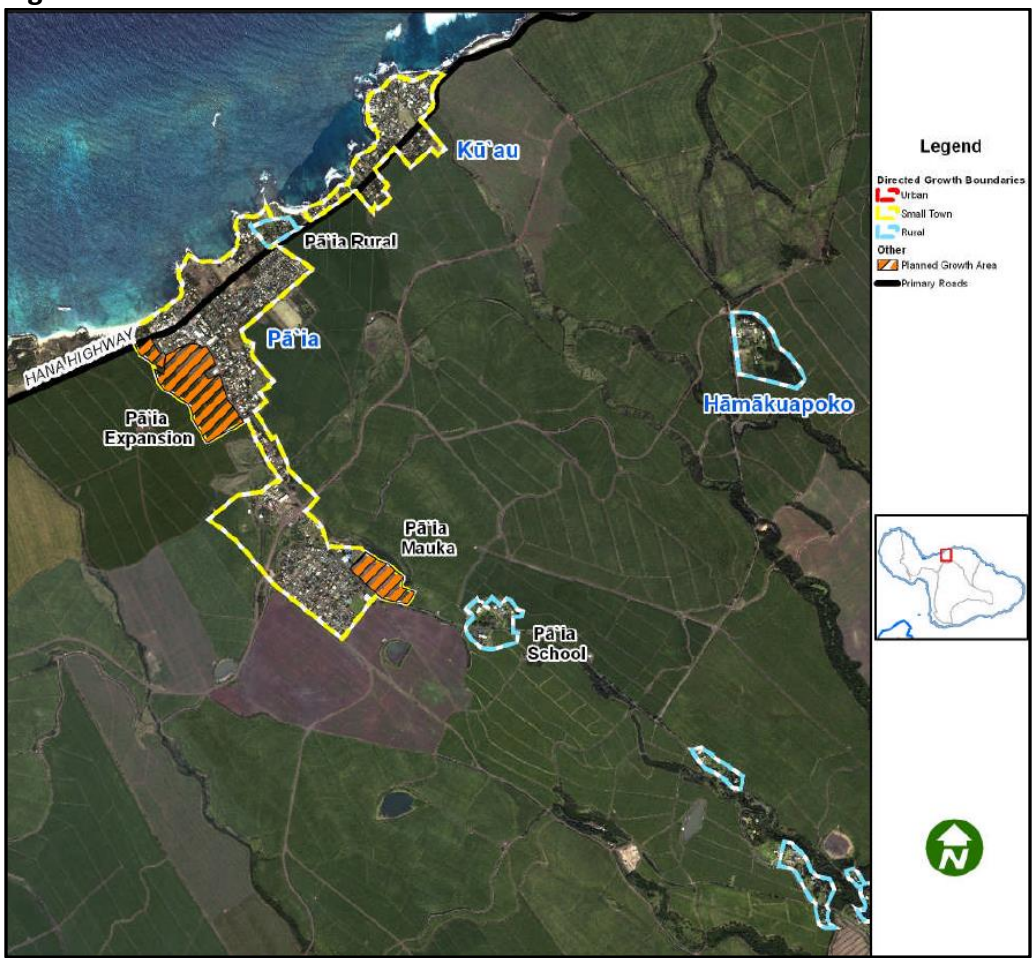
Planned protected areas include Corn Mill Camp and Upcountry Greenway. No water demand is associated with the protected areas.

Pā`ia-Ha`ikū Community Plan Region

Pā`ia and Kuau are located in the Central ASEA and served by the MDWS Central System. Three planned growth areas are within the Central ASEA:

- Pā`ia Expansion is a 41 acre expansion of mixed-use west of Baldwin Avenue. About 207 single family and multi-family units would be developed
- Pā`ia Mauka is a 15 acre expansion of Skill Village that would allow about 68 units
- Old Maui High School Campus Revitalization is the remains of the Hamakuapoko plantation camp. About 24 acres could potentially be developed as youth-educational camp, conference center, farmers market and other facilities

Figure 15-20 Pā`ia Planned Growth Areas



Source: Maui Island Plan

Table 15-26 Planned Growth Central ASEA Pā`ia (MDWS Central System)

Planned Growth Area	# Units	# Acres	Projected Demand (mgd)
Pā`ia Expansion	207	41	0.124 – 0.123
Pā`ia Mauka	68	15	0.048 – 0.45
Old Maui High School Campus Revitalization	N/A	24	0.75
Total:	**275**	**80**	**0.165 – 0.240 MGD**

Development Projects and Projected Demand in Planned Growth Areas

The Planning Department maintains a list of large development projects that have come to their attention, some of which have been entitled, committed or are supported by the Maui Island Plan but not necessarily the Community Plan.

Development projects in the Central ASEA and potentially served by the MDWS Central System and Wailuku ASEA resources is addressed in the Wailuku ASEA Chapter 14.6. As stated in Chapter 14.6, the Wailuku ASEA report includes development projects within *Kahului, Kama`ole and Pā`ia aquifers*, and development projects throughout the Central ASEA that are primarily served by water resources from the *Wailuku ASEA*. Assumptions are based on proximity to the MDWS Central System, general elevation and source specific information for proposed projects. A few proposed residential development projects are known or expected to be served by private purveyors' groundwater sources in the Kahului aquifer , for example the Wai`ale Development. Some development projects plan to use brackish water in the lower Kama`ole aquifer, for example the Honua`ula project plans which would treat brackish water with reverse osmosis to serve potable demand. Table 14.32 in the Wailuku ASEA report excludes development projects located at elevations ranging from 700 to 4,000 feet elevation that would be primarily served by the MDWS Upcountry System.

The map below shows the Growth Boundaries, the location of projects on the 2016 list, municipal wells (public and privately owned) and the MDWS service areas. The MDWS Upcountry and Central Systems are not connected. Projects within the MDWS service areas could be serviced by private wells and water systems, opt to develop alternative sources, or be subject to other system restrictions such as the Upcountry Meter Priority List.

Projects summarized in the table below do not constitute a plan or commitment by MDWS to serve such projects. While unlikely all projects will be approved as proposed, or constructed once approved, the List is instructive as to location and planning for water sources. Development in the Central ASEA would primarily be served by the MDWS Central System or the MDWS Upcountry System.

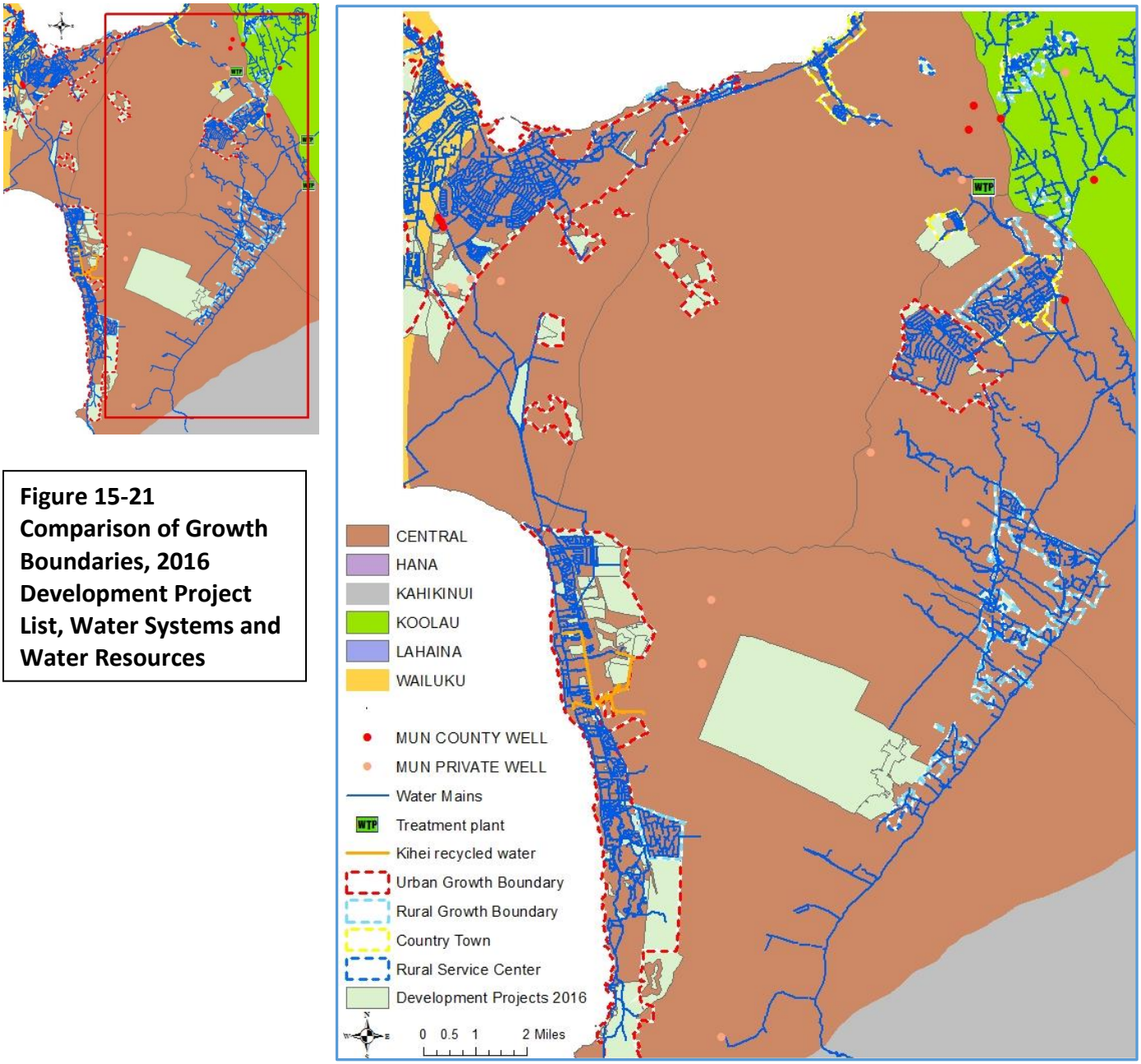


Figure 15-21
Comparison of Growth Boundaries, 2016 Development Project List, Water Systems and Water Resources

Comparing proposed development projects potentially served by the MDWS Central System in Table 14.31 to projects potentially served by the MDWS Upcountry System, projected residential demand for projects in Wailuku and Central aquifer sectors total 11.725 mgd.

Table 15-27 2016 Development Projects Aquifer Sector Location and Potential Aquifer Source (mgd)

Development Project Location	Potential Source	2016 Development Projects List		
		Entitled	Not Entitled	Total
Wailuku ASEA	MDWS Central System (Wailuku ASEA)	1.323	1.996	3.319
Central ASEA (Kama`ole, Kahului, Pā`ia aquifers)		3.072	3.875	6.947
Central ASEA (Kama`ole aquifer)	Kama`ole aquifer	0.666	0	0.666
Central ASEA (Makawao aquifer)	MDWS Upcountry System (Makawao aquifer, Ko`olau surface water)	0.296	0.497	0.793
Total:				**11.725**

Source: MDWS, Maui County Planning Department, Long Range Planning Division.

Domestic Use

There are six installed domestic wells in the Central ASEA but there was no pumpage reported in 2014 for domestic uses. As reporting is expected to improve through CWRM efforts, it is assumed that there are some active domestic wells utilized throughout the Central ASEA.

Industrial Use

About 0.208 mgd of groundwater is extracted from the Kahului for industrial purposes. Committed development projects within designated urban growth boundaries include some industrial development. Projected growth is assumed to increase based on population growth rate. Additional industrial demand for about 100 acres is associated with the DHHL Puunene Tract.

MDWS Water Demand Projections

Water demand projections for the MDWS Central System were analyzed in the Wailuku ASEA report. Table 14-33 shows 2035 projected consumption from the Central System would be 34.6 mgd, an increase from 21.1 in 2014. Projected water consumption for the MDWS Upcountry System would be about 7.02 mgd in 2035 based on population growth. Projected water use based on low to high growth scenarios are shown in the table below for the two MDWS systems.

Table 15-28 Projected Consumption by MDWS District, Base, High and Low Scenarios (mgd)

District	2014	2035 Base	2035 High	2035 Low
Central System	21.154	32.294	35.778	29.533
Upcountry System	6.263	7.020	7.573	6.420

Excludes Kula Ag Park

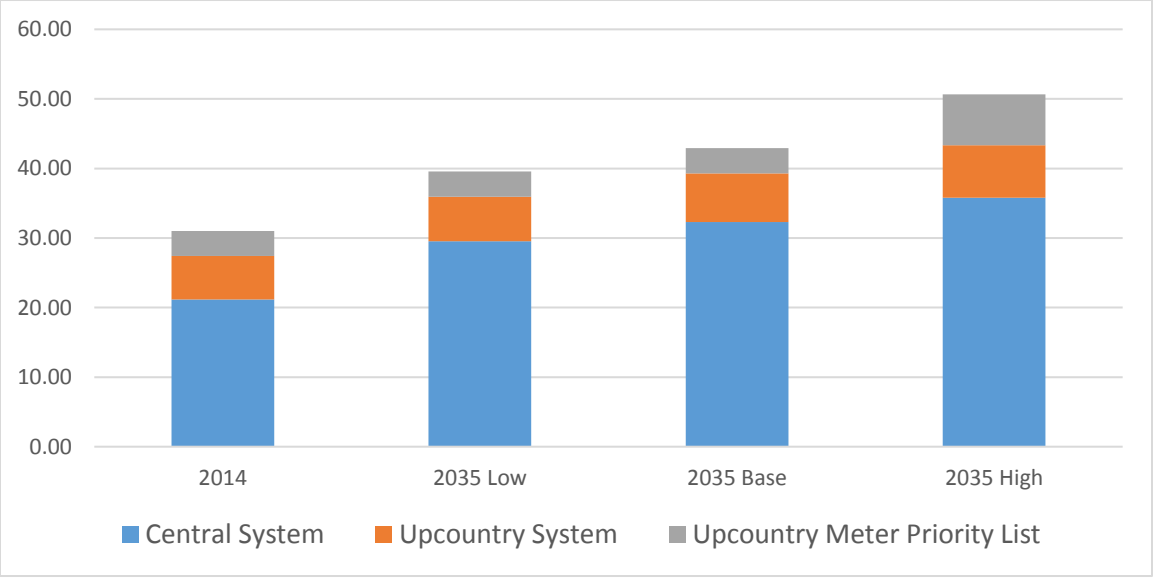
Water consumption in the table above is the volume water billed. Water produced at the source is higher due to water losses. The projected increase of 0.76 mgd for the Upcountry system does not represent demand on the Upcountry Meter Priority List. The List represents about 1,800 requests for an estimated total of 7.3 mgd. Historically, about 50 percent of the requests do not result in an installed meter. Projected demand to satisfy the priority list is therefore estimated within the range of 3.6 to 7.3 mgd.

Table 15-29 Comparison of Upcountry District With and Without Meter list (mgd)

Criteria	2014	2035	Increase (mgd)
Upcountry/Makawao	6.2	7.0	0.7
Upcountry/Makawao + Meter List	6.2	9.9 – 13.5*	3.6 – 7.3

*Assumes 50% - 100% of meter list requests are developed.

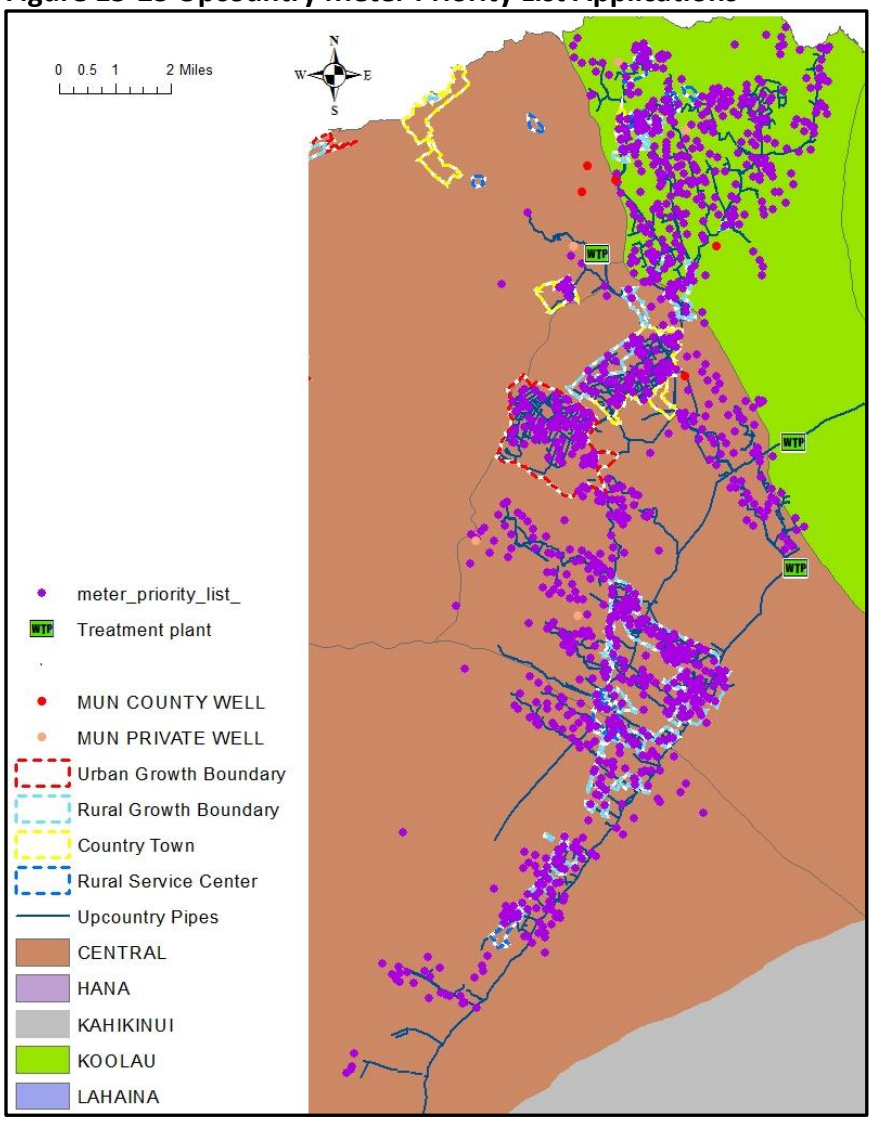
Figure 15-22 Projected 2035 Demand Central System and Upcountry System with Meter Priority List (mgd)



About two-thirds of the requests are for development that would be located outside designated growth areas. Sources for requests in Ha`ikū are primarily served by basal wells with sufficient backup capacity to reliably add new services. Sources for requests on the Upper Kula system are East Maui streams in the Waikamoi area that are subject to Instream Flow

Standards and vulnerable to drought. There remains uncertainty over the number and timing of new meters as well as occupancy.

Figure 15-23 Upcountry Meter Priority List Applications



Private/Small System Water Consumption Data Projections

Information on projected growth and demand for privately owned public water systems was queried but not available. Maui Island Plan population projections (Socio-Economic Report, 2014 Draft) were applied to 2014 reported water use.

Kula 1800 Subdivision is noted to have entitlement water from the Hamakua ditch dated February 8, 2008. In an agreement between the County and Maui Land & Pineapple Company (ML&P), the county agreed that it will sell to ML&P water sufficient to irrigate 326 acres of the

712 acre property 2-3-002:004 of pineapple, or sufficient water for any other crop not exceeding water requirements for pineapple. The agreement does not specify a range of water use. Average demand for pineapple per acre is 1,077 gpd or 351,192 gpd for 326 acres. (Letter dated April 18, 2008 from the University of Hawaii College of Tropical Agriculture and Human Resources Cooperative Extension Service)

Wai`ale planned growth area geographically located within the Central ASEA is planned to be serviced from Waikapū aquifer in the Wailuku ASEA. The maximum estimated demand for the Wai`ale planned growth area is about 0.8 mgd.

Other Population Based Demand Projections

There are likely individual households that are not served by any public water system and no groundwater pumpage or diverted surface water is reported. Some domestic use from wells is assumed to occur that is not reported. There are known rainfall catchment systems scattered in the eastern portion of Makawao aquifer but there is no official inventory.

15.6.5. Agricultural Demand Projections

Non-potable agricultural irrigation demand is not coordinated to population growth and represent additional demand. Agriculture is by far the most extensive land use and water use throughout the Central ASEA between the HC&S plantation overlying the Pā`ia and Kahului aquifers, and the Upcountry diversified farming overlying the Makawao and Kama`ole aquifers.

Kalo Lo`i and Appurtenant Rights

There are no identified kalo lo`i and appurtenant right uses in the Central ASEA. Proposed Interim Instream Flow Standards (IIFS) in Na Wai Eha streams of Wailuku ASEA and East Maui Streams of Ko`olau ASEA address and protect instream uses. The Hearing Officer's 2017 Proposed decision for the Na Wai Eha contested case and the CWRM June 20, 2018 decision for the East Maui Streams contested case are assumed to satisfy in-stream flow required for healthy taro cultivation demand. The WUDP Ko`olau Sector Report was drafted and submitted for review prior to the June 20, 2018 CWRM decision for East Maui Streams. However, a summary of IIFS by stream according to the 2018 decision is provided in this sector report as Appendix 15 A.

Diversified Agriculture on HC&S Plantation

HC&S has approximately 30,000 acres of agricultural land in the Central ASEA that historically was irrigated with water from Ko`olau ASEA surface water, Wailuku ASEA surface water and groundwater from the Pā`ia and Kahului aquifers. The land and water use on the HC&S plantation has changed quickly over the same period the WUDP update is drafted. At the time A&B/HC&S

submitted their proposed findings for their Diversified Agriculture Plan (HC&S Findings of Facts, Conclusion of Law and Decision & Order, June 2017) in June 2017, the water use for the plantation was less than 20 mgd. A&B stated that the Diversified Agriculture Plan is constantly evolving as agreements of cattle grazing on 4,000 acres, renewable energy crops, a sale of 850 acres to the County for an ag park, and a commercial feedstock operation was being developed over 2017.[62] 2014 is used as base year for the Water Use and Development Plan existing water uses. Where surface water diversions 2014 data was missing, 2011 – 2015 average reported data was used. However, because the significant changes in water use since December 2016, agricultural demand projections consider inventoried 2017 water use in the Central ASEA. Existing 2014 and 2017 agricultural water use, imported water from Ko`olau and Wailuku aquifer sectors are shown in the table below. Agricultural use includes commercial agriculture such as the Kula Ag Park and Maui Pineapple Company, using surface water imported from Ko`olau ASEA.

Table 15-30 Central ASEA 2014 – 2017 Agricultural Water Use (mgd)

	2014	**2017**
Kahului Aquifer	28.222	0.313
Pā`ia Aquifer	29.097	0.000
Kama`ole Aquifer	0.000	0.001
Makawao Aquifer	0.000	0.000
Total Groundwater Pumpage	**57.319**	**0.314**
WAILUKU ASEA Surface Water Export*	18.000	5.000 - 7.000
KO`OLAU ASEA Surface Water Export**	116.133	20.000 – 23.000
CENTRAL ASEA Total Use	191.452	25.314 - 30.314

*Resource use accounted for in the Wailuku ASEA Report Chapter 14.6.4 and Table 14.34
**Estimated portion used for Ag irrigation based on surface water reported. Does not account for water losses between source and use.

Preliminary agricultural demand projections in the WUDP update applied percent acres cultivated of the HC&S plan and Important Agricultural Lands (IAL) as alternative low to high demand scenarios. Projections included **all of the HC&S plantation, including lands historically irrigated with surface water from Na Wai Eha.** Scenario 1 represented 100% of HC&S Diversified Agriculture Plan, based on the acreage and water duty proposed in HC&S's plan and accounting for the entire plantation regardless of water source. Surface water from the designated Nā Wai `Ehā has not been allocated today. As discussed in the Wailuku Aquifer Sector Report, Chapter 14.6.4, it is reasonable to use the CWRM Hearing Officer's proposed 2017 Decision as basis for water duty and allocations from Nā Wai `Ehā . **Projected agricultural demand for fields served by Nā Wai `Ehā was assessed and accounted for in the Wailuku Aquifer Sector Report Chapter**. These demand projections are shown here separately in order to not double count demand and resource use. HC&S projected demand for the portion of the Diversified Agriculture Plan that would be served by the EMI system and supplemented by

[62] CCH-MA-13-01 Hawaiian Commercial and Sugar Company's Submission of Amended Proposed Findings of Fact and Conclusions of Law, June 2017

groundwater to 89.23 mgd. Irrigation needs were recognized in CWRM's June 2018 Decision of the East Maui Streams Contested Case.[63] The table below does not account for water losses.

Table 15-31 HC&S Diversified Agriculture Plan Projected Demand

	Scenario 1: 100% of Diversified Agriculture Plan, Fields Served by EMI, Na Wai Eha and Groundwater	**Scenario 2: 100% of Diversified Agriculture Plan, Fields Served by EMI and Groundwater**
Irrigated Acres	30,250	26,996
Irrigation Demand (mgd)	107.79	89.23

The Diversified Agriculture Plan envisions irrigating 26,996 acres of fields previously irrigated with surface water from Ko`olau ASEA delivered by the EMI system, and brackish water pumped from Pā`ia and Kahului aquifers. An additional 3,954 acres are planned for unirrigated pasture where sufficient rainfall supports livestock. An additional 227 acres of unirrigated forestry is proposed. This scenario represents a high growth scenario, equivalent to Scenario 2 in the table above. Failure to establish viable crops on former plantation lands, leaving most plantation lands fallow represents a low growth scenario. The type of crops and timing of repurposing the plantation is highly uncertain. As a conservative approach the selected scenario is a phased build-out from 25 and 50 percent of Important Agricultural Lands (IAL) to 100 percent of the Diversified Agriculture Plan in active use over the 20-year planning period. In the June 2018 CWRM decision of the East Maui Streams contested case, the average water duty of about 3,305 gpd per acre was recognized. (While 2,500 gpd was applied for surface water use permits in Na Wai Eha). It is noted again that the Central ASEA Sector Report addresses the plantation that is served by the EMI system and/or brackish water from the Central ASEA, which contain almost all lands designated IAL. There is some overlap with fields served by Na Wai Eha. Areas served by the EMI system is shown in the figure below. Demand for the HC&S plantation within the EMI service area is summarized in the table below.

[63] June 20, 2018 CCH-MA13-01 Findings of Fact, Conclusions of Law, & Decision and Order.

Figure 15-24 Important Agricultural Lands, EMI Ditches and Service Areas, and Rainfall for HC&S Lands

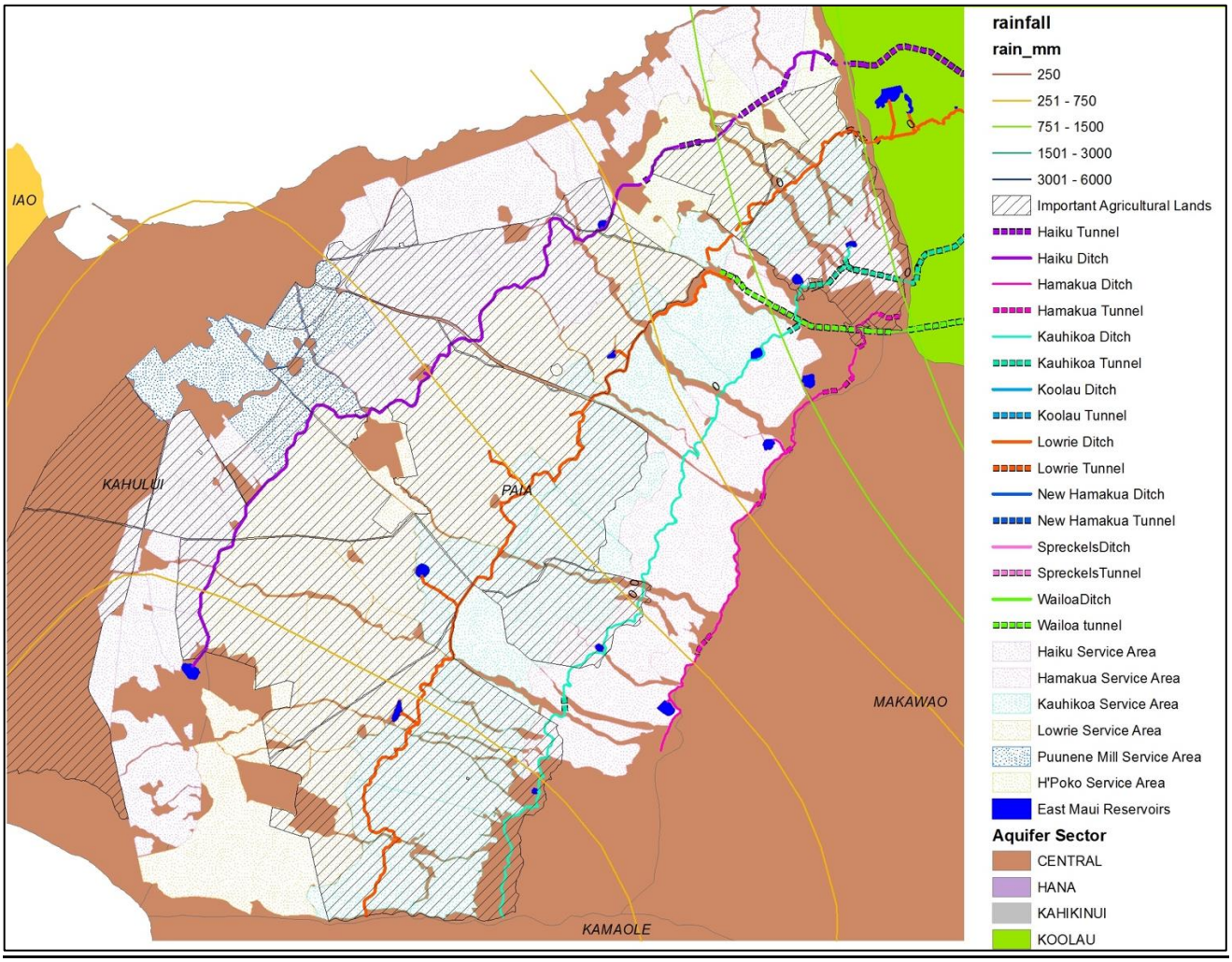


Table 15-32 Projected Low to High Agricultural Demand for A&B/HC&S Lands within EMI Service Area 2017 - 2035

	Low-Growth Scenario 25% of IAL Farmed	Mid-Growth Scenario 50% of IAL Farmed	High-Growth Scenario: 100% of Plantation Served by EMI and/or Brackish Water per HC&S Diversified Agriculture Plan
Time Frame	2020	2030	2035
Irrigated Acres	6,823	13,647	26,996
Irrigation Demand (mgd)	23.20	46.40	89.23

The extent to which brackish water from Pā`ia and Kahului aquifers can and will be used in highly uncertain and probably directly related to the amount of irrigation return recharge over the same aquifers. It is anticipated that decreased irrigation return recharge will increase salinity and the sustainable level of groundwater use, compared to historic levels. The tolerance of various crops to brackish water quality further adds to uncertainty in use.

Diversified Agriculture Outside the HC&S Plantation

Upcountry Maui has a range of actively cultivated crops while the dry slopes between Kula and the coastal area of Kama`ole aquifer is primarily unirrigated pasture. Based on the 2015 Agricultural Baseline and applying irrigation water duty in accordance with Hawaii Department of Agriculture guidelines, water demand outside the HC&S plantation of the Central ASEA would be 9.9 mgd. Use includes the Kula Ag Park, the Maui Pineapple Company and Monsanto seed production on the Central isthmus. Projecting a potential 20 percent increase in agricultural use, and accounting for the planned expansion of the Kula Ag Park represents a high growth scenario. The table below shows breakdown by crop, acreage and water duty over the planning period.

Table 15-33 Central ASEA Agricultural Water Demand (mgd), 2015 Agricultural Baseline (acreage), Agricultural Water Use Based on Crop, Water Use Rates - HDOA Guidelines

Crop	Acreage	Water Use Rate (gpd per acre)	Estimated Water Demand 2015 (mgd)	Estimated Demand 2035 (2015*20%)
Banana	16.70	3,400	0.057	0.068
Coffee	10.58	2,900.00	0.031	0.037
Diversified Crop	1,197.22	3,400.00	4.071	4.885
Flowers / Foliage / Landscape	97.97	4,000-6,000	0.490	0.588
Pasture	53,720.04	0-6,700	0.000	0.000
Pineapple	1,093.52	1,350.00	1.476	1.772
Seed Production	754.41	3,400.00	2.565	3.078
Taro	0.23	100,000-300,000*	0.035*	0.041*
Tropical Fruits	21.69	4,400-10,000	0.156	0.187
Kula Ag Park Expansion	302.00		1.027	1.232
CENTRAL Total	**57,214.35**		**9.908**	**11.888**

Coffee: per Brian Kau, HDOA, personal communication 10/12/2016.
Wetland taro: Per CWRM CC D&O, Na Wai Eha and East Maui Streams

15.6.6. Irrigation Demand Projections

Reported irrigation use of 3.68 within the aquifer sector includes brackish water used for golf course, resort and landscaping irrigation purposes. Over 75 percent of irrigation withdrawals are from the Kama`ole aquifer but is likely under-reported. This is in addition to irrigation uses served by the MDWS Central and Upcountry systems. Although irrigation needs may not correspond directly to population growth, it's prudent to project an increase in demand based on population growth, which is at a higher rate than the de facto population growth. Demand would increase from 3.68 mgd to 5.59 mgd over the planning period.

In addition to groundwater withdrawals for irrigation, recycled water from the Kihei Wastewater Reclamation Facility provides up to 1.75 mgd during peak summer months. Reclaimed water is distributed to 24 commercial properties in South Maui for landscape and agricultural irrigation, cooling, fire control, erosion and dust control, drinking water for cattle and other uses.[64] The volume of R-1 water reused varies seasonally. It is estimated that about 1 mgd is reused on average for irrigation purposes. An additional 0.08 mgd of reclaimed water is generated and used at the Makena Resort, primarily for golf course irrigation. The reclamation facility is undergoing an upgrade to further integrate on site wastewater generation and use.

15.6.7 Population Growth Based Water Demand Projections Analysis

To determine source needs and accommodate planned growth consistent with the MIP, projected demand is summarized in the table below. For municipal needs, water production rather than billed consumption is used as 2014 basis for projections. Water needs for the MDWS Central System and the Upcountry System are projected separately and in combination with all other water needs within the Central ASEA dependent on resources within and outside the hydrologic unit.

Department of Hawaiian Homelands (DHHL) land use plans are not specifically addressed in the MIP or identified as planned growth areas. It is therefore assumed that DHHL water needs are **not** accounted for in municipal population growth based projections. Potable and non-potable demands for the Kēōkea/Waiohuli tract are currently served by the MDWS Upcountry System with a remaining allocation insufficient to meet projected needs. A MDWS allocation from the Upcountry System of 0.5 mgd has been partially credited against total projected potable demand of .809 mgd. There is no restriction to use the allocation for potable uses only. Less than half of the allocation has been used for development over the 20-year period since the 1997 agreement.

The selected 20-year projected demand scenario is population mid-growth based, that account for the MDWS Central Maui and Upcountry systems as a whole, with the addition of DHHL

[64] Department of Environmental Management, Wastewater Reclamation Division, South Maui R-1 Recycled Water Verification Study, December 2009

needs and the Upcountry Meter Priority List. Total 2035 demand is projected to 165.27 mgd. Land use based demand is included in Table 15-34 below as the alternative scenario. Population growth based sub-scenarios are illustrated as follows:

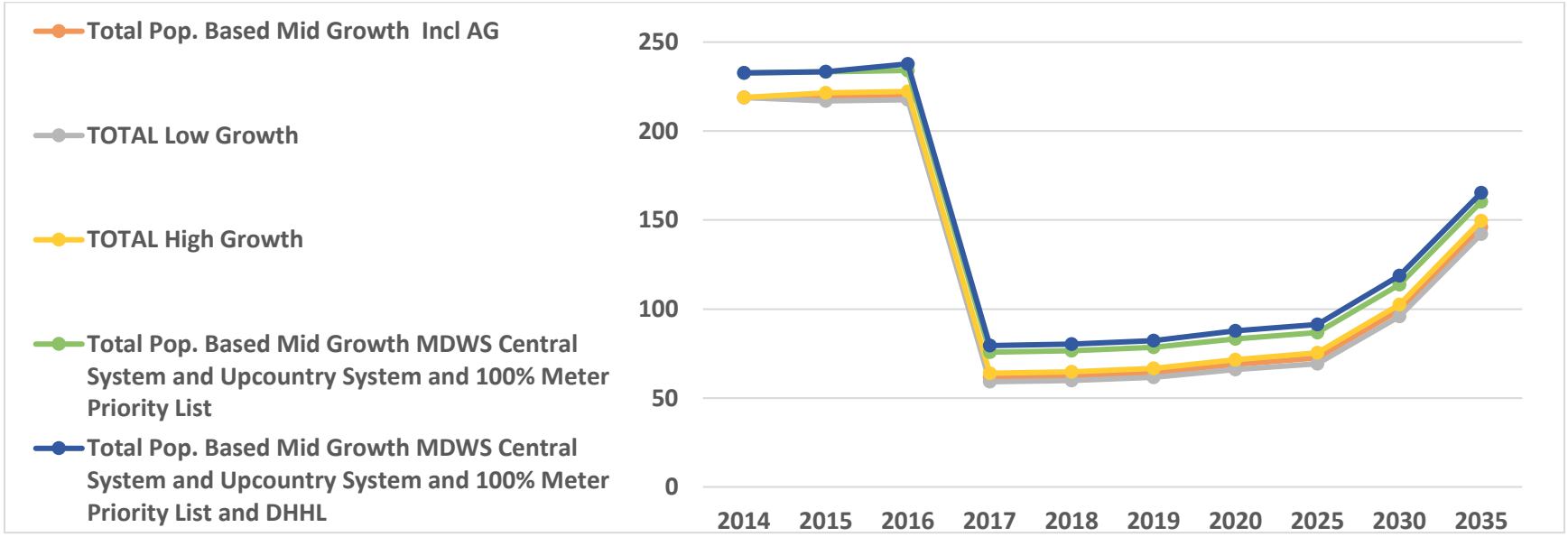
1. Municipal use is shown as "Municipal MDWS", "Municipal Private and Municipal Central ASEA Only", which includes use **within** the Central aquifer sector only. The portions of the MDWS systems that are located in Ko`olau and Wailuku ASEAs are excluded.
2. Projected demand for the MDWS Central System **as a whole** and MDWS Upcountry system **as a whole** are shown as comparison.
3. Total projected use within the Central ASEA only are shown including and excluding Agriculture. Demand projections for the HC&S plantation lands inherently has significant uncertainties over the planning period. The actual use of 191.45 mgd in 2014 is drastically reduced to 32.43 mgd in 2017. The 2017 projection is based on actual reported pumpage and diversions for 2017 less estimated uses for non-agricultural needs (such as reservoir storage for fire protection). Projected 2020 - 2025 demand roughly represents about 25 percent of IAL farmed; projected 2030 demand equals roughly 50 percent of IAL farmed, and 2035 demand 100 percent of the HC&S Diversified Agriculture Plan served by the EMI system and sources within the Central ASEA.
4. Total demand within the Central ASEA only, including Agriculture are projected for low to high growth scenarios.
5. The selected scenario includes the MDWS Central and Upcountry systems **as a whole**: "Total Population Based Mid Growth MDWS Central System and Upcountry System". It is noted that demand and source development for the MDWS Central System as a whole is analyzed and accounted for in the Wailuku ASEA Report, Chapter 14. Supply options and strategies for the MDWS Central System are addressed in the Wailuku ASEA Report. Because most municipal use within the Central ASEA is served by water resources in Wailuku ASEA, the two hydrologic units and sector reports are necessarily linked.
6. The Upcountry Meter Priority List is added to the selected scenario. The List does not represent population growth but considered committed water over the planning period. Historically about 50 percent of applications on the List have resulted in new water meter services. Amendments to county code over time have mitigated the cost and burden on applicants on the List. Therefor it is prudent to account for the entire List in planning for new source needs.
7. Department of Hawaiian Homeland needs are added to the selected scenario. It is not evident that planned DHHL developments is factored into population growth in the Maui Island Plan or community plans.

TABLE 15-34 Projected Water Use by CWRM Category to 2035, CENTRAL ASEA

	2014	2015	2016	2017	2018	2019	2020	2025	2030	2035
POPULATION BASED										
Domestic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Industrial	0.208	0.211	0.217	0.222	0.227	0.232	0.237	0.261	0.290	0.316
Agriculture	191.452	191.452	191.452	32.434	32.534	33.749	35.415	35.415	58.200	101.030
Irrigation	3.683	3.744	3.836	3.927	4.018	4.110	4.201	4.627	5.133	5.591
R-1 Irrigation	1.008	1.025	1.050	1.075	1.100	1.125	1.150	1.267	1.405	1.531
Municipal MDWS	*22.235*	*22.609*	*23.160*	*23.712*	*24.263*	*24.814*	*25.366*	*27.939*	*30.995*	*33.761*
Municipal Private	*0.235*	*0.239*	*0.245*	*0.250*	*0.256*	*0.262*	*0.268*	*0.295*	*0.327*	*0.356*
Municipal CENTRAL ASEA Only	**22.470**	**22.899**	**23.423**	**23.960**	**24.509**	**25.070**	**27.928**	**30.871**	**34.303**	**37.501**
MDWS Central System	**22.274**	**22.699**	**23.219**	**23.751**	**24.295**	**24.852**	**27.685**	**30.602**	**34.005**	**37.174**
MDWS Upcountry System	**7.610**	**7.693**	**7.785**	**7.879**	**7.973**	**8.069**	**8.155**	**8.292**	**8.432**	**8.530**
Military	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL CENTRAL ASEA ONLY Mid Growth excl. AG	**27.368**	**27.880**	**28.526**	**29.184**	**29.854**	**30.537**	**33.517**	**37.026**	**41.132**	**44.939**
Total Mid Growth incl. AG	**218.820**	**219.332**	**219.978**	**61.618**	**62.388**	**64.286**	**68.932**	**72.441**	**99.332**	**145.969**
TOTAL Low Growth	218.820	216.948	217.539	59.122	59.835	61.675	66.066	69.276	95.815	142.126
TOTAL High Growth	218.820	221.529	222.226	63.917	64.740	66.692	71.573	75.359	102.573	149.510
Total Mid Growth MDWS Central System and Upcountry System	225.461	226.039	226.754	68.463	69.304	71.273	75.961	79.493	106.388	152.998
Total Mid Growth MDWS Central System and Upcountry System and 100% Meter Priority List	**232.761**	**233.339**	**234.054**	**75.763**	**76.604**	**78.573**	**83.261**	**86.793**	**113.688**	**160.298**
DHHL Additional Potable Kahului Aquifer	0.000	0.000	1.734	1.734	1.734	1.734	1.734	1.734	1.734	1.734
DHHL Additional Potable Kama`ole Aquifer	0.000	0.000	0.096	0.096	0.096	0.096	0.349	0.345	0.809	0.813

DHHL Additional Non Potable Kama`ole Aquifer	0.000	0.000	0.000	0.000	0.000	0.000	0.578	0.578	0.578	0.578
DHHL Additional Non Potable (no source identified)	0.000	0.000	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564	1.8564
Total Pop. Based Mid Growth MDWS Central System and Upcountry System, 100% Meter Priority List and DHHL	**232.761**	**233.339**	**237.740**	**79.449**	**80.290**	**82.260**	**87.779**	**91.311**	**118.666**	**165.279**
LAND USE BASED										
County Zoning	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259	433.259
DHHL	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011	4.011
TOTAL Land Use Based	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**	**437.27**

Figure 15-25 Projected Water Use to 2035, Population Growth Based (Low, Medium, High) Central ASEA + MDWS Central and Upcountry Systems + Upcountry Meter Priority List + DHHL (mgd)



15.7 Water Resource Adequacy

The analysis of available resources and projected 20-year demand result in the following findings:

1. Groundwater sustainable yield (SY) and surface water within the hydrologic unit is not sufficient to supply population growth and planned growth areas.
2. Decreased transport of Ko`olau surface water for irrigation of lands overlying the Kahului and Pā`ia aquifers will probably result in higher chlorides and less fresh water available to withdraw beyond these aquifers' natural sustainable yield.
3. Surface water from the Ko`olau ASEA under median (Q50) conditions (subject to IIFS established 6/20/18) will probably meet the initial phase of transition to diversified agriculture on the Central isthmus. Median stream flow conditions will not be sufficient to realize the full Diversified Agricultural Plan.
4. Surface water under low flow, or drought (Q90) conditions (subject to IIFS established 6/20/18) will not be sufficient to meet initial transition to diversified agriculture and projected municipal demand of the MDWS Upcountry System.
5. The Wailuku ASEA Report determined that growth on the MDWS Central System requires import of Wailuku ASEA groundwater, import of Ko`olau ASEA groundwater, Wailuku ASEA surface water and aggressive conservation in addition to a small portion of Central ASEA groundwater.
6. Non potable irrigation and industrial demand can be met with water resources within the Central ASEA. Municipal and agricultural demand requires supplemental groundwater imports and alternative water resources.

15.7.1 Land Use Full Build-Out Based Water Projections

Full build-out of land use classifications throughout the Central ASEA represents 437 mgd in total water use. County zoning in the Central ASEA is designated Agriculture for about 78% of zoned lands. Large sections of Agricultural land are non-irrigated pastures on the dry southwest slope of Haleakala with little or no projected water use. Another 36,000 acres make up the former HC&S sugarcane plantation now in transition. Low to high "growth" or active use of these lands are assessed based on percentage lands in active cultivation over the 20-year planning period. Therefore, land use build-out projections are used for the HC&S plantation lands, supplementing population growth based projections. A full build-out scenario of other county zoned lands is not realistic nor supported by the Socio-Economic Forecast.

The Maui Island Plan, the Socio-Economic Forecast and the community plans do not specifically address Department of Hawaiian Homelands water needs for their planned developments in the Central ASEA. It is therefore assumed that DHHL needs are **not** factored into population growth. DHHL water use projections for the 20 year planning period are added to population growth based projections.

15.7.2 Population Growth Based Water Demand Projections (20-Year)

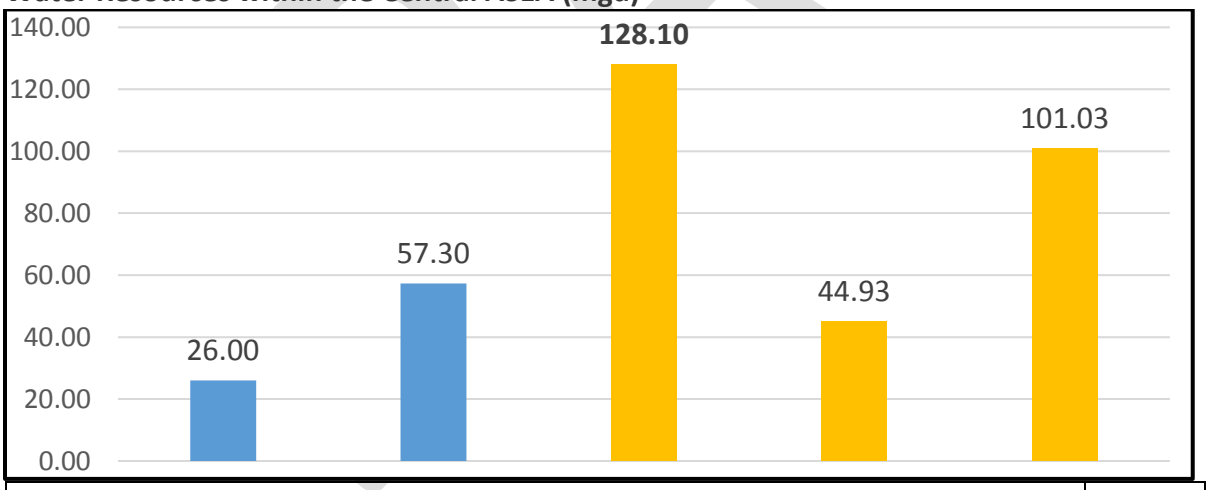
The primary planned growth areas according to the Maui Island Plan are located in the Central ASEA from Kahului throughout the Central isthmus to the South Shore. Most of the population centers and planned growth areas are, or are anticipated to, be served by the MDWS Central System. Total population growth-based demand in the Central ASEA as a separate hydrologic unit is about 44.9 mgd. Considering the MDWS Central System and Upcountry System as a whole, population growth-based demand would be 45.7 mgd. Including the Upcountry Meter Priority List (which is not population growth based) demand would be about 53 mgd.

Land use-based projections are used to add agricultural irrigation needs and DHHL needs for a grand total of 165.2 mgd.

The MDWS Central System is addressed in the Wailuku ASEA Report. Total Central ASEA water use demand not accounted for elsewhere in this WUDP update is therefore **128.10 mgd**.

The chart below shows resources within the Central ASEA, brackish groundwater available in 2014, based on reported pumpage. Available brackish groundwater above natural sustainable yield is not known but assessed below under *Surface Water Imports from Ko`olau Aquifer Sector Area.*

Figure 15 26 Population Mid-Growth Based 20-Year Water Demand Projections and Available Water Resources within the Central ASEA (mgd)



Groundwater Sustainable Yield	26.00
Pā`ia and Kahului Brackish GW Available in 2014	57.30
DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land use based AG and DHHL (excl. MDWS Central System)	**128.10**
Demand Pop. Mid-Growth CENTRAL ASEA hydrologic unit only	44.93
Demand AG only	101.03

Population growth Based Water Demand Projections MDWS Central System

As stated in the Wailuku ASEA Report, MDWS Central System demand is projected to increase from about 21.3 mgd to 35.6 mgd. With the additional use of Maui Lani wells from the Central ASEA, demand increases from about 22.2 mgd to 37.2 mgd. As shown in Table 14.38, most of future supply for the MDWS Central System would come from the Wailuku ASEA: about 19.1 mgd of groundwater and about 3.2 mgd of surface water. Potable groundwater from the existing Maui Lani wells in Kahului aquifer would supply 1.1 mgd. Expanded conservation programs are projected to decrease per capita water use by 8 percent over the planning period and substitute about 5 mgd of needed water resources. The remaining 8 mgd for the MDWS Central System would come from potable groundwater imports from the Ha`ikū aquifer in the Ko`olau ASEA.

Population Growth Based Water Demand Projections Upcountry

Projected 2035 demand without the Upcountry Meter Priority List based on the selected mid-growth scenario is 8.5 mgd and 15.8 mgd accounting for the entire List. The combined surface and groundwater sources have a production capacity of 17.9 mgd: 13 mgd from surface water and 4.9 mgd from groundwater. Reliable capacity must consider system standards and limitations on the use of wells according to the following factors:

1. The largest surface water treatment facility being out of service: the Kamole Weir at 6.0 mgd capacity
2. The Po`okela Well at 1.3 mgd production capacity
3. The Hamakuapoko Wells at 1.5 mgd, which is only available at times of emergency.

Adjusting for the factors above reduces production capacity by 8.8 mgd, to reliable capacity of 9.1 mgd. Additional source capacity needs are 6.7 mgd to meet the 2035 projected demand of 15.8 mgd.

The Hamakuapoko wells at 700 foot elevation and above can convey up to about 0.9 mgd combined to the MDWS Upcountry system during droughts.

Planned Growth Areas in Kahului Aquifer

As stated in Chapter 15.6.4, two planned growth areas would potentially be served by groundwater from Kahului aquifer: Wai`ale mixed-use town development and Pulehunui industrial development. It is assumed that the planned housing development is accounted for in the socio-economic forecast and therefore included in population growth based demand.

The Pulehunui industrial development of up to 3.8 mgd demand does not appear to be accounted for in population growth based industrial water use projections, which total 0.316 mgd by 2035. The demand for Pulehunui could be considered additional to population growth based demand, similar to the proposed DHHL Puunene developments of 3.5 mgd. It is not

assumed that the Pulehunui industrial development would be served by the MDWS Central system and Wailuku ASEA resources.

Wells in the Kahului aquifer, including the Wai`ale wells, may see rising chloride levels due to the decrease in irrigation return flow from East Maui stream diversions to HC&S plantation lands overlying the aquifer. Because the impact on the Kahului aquifer yield and quality is highly uncertain, it is not assumed that significant yield of freshwater supply is available beyond natural SY of 1 mgd to meet potable demand. Non-potable irrigation needs for the Wai`ale development can probably be supplied from the existing Wai`ale wells in Kahului aquifer. Potable demand will most likely be met by water resources in the Wailuku ASEA, such as Waikapu aquifer. On site groundwater development for planned growth at Pulehunui, as well as the DHHL Puunene project, may be feasible for non-potable purposes. Source adequacy is highly uncertain due to the anticipated decrease in irrigation return recharge with the cessation of sugarcane cultivation.

Planned Growth Areas in Pā`ia Aquifer

The three projects listed in Table 15-30 all overlie the Pā`ia aquifer. It is assumed that Pā`ia Expansion and Pā`ia Mauka housing projects are accounted for in population growth based demand. The projects are within the MDWS Central System service area. Source to supply projected demand in Pā`ia include ground and surface water from Wailuku ASEA and groundwater import from Ko`olau ASEA (see Table 14-38).

The Old Maui High School Campus Revitalization Project is not within the MDWS Central System service area and is probably not accounted for by population growth based private municipal water use projections, which total 0.356 mgd. Source alternatives for the projected 0.75 mgd project demand are not determined but could include groundwater development from the Pā`ia aquifer.

The 825 unit planned Haliimaile Development mostly overlies the Pā`ia aquifer and could potentially be served by existing wells in the Pā`ia aquifer. High nitrate levels are in nearby well development for the Baldwin Estates subdivision and is likely an issue.

Water quality in the Pā`ia aquifer ranges from brackish close to the coast to potable quality above 700 feet ground elevation. Municipal wells in the Pā`ia aquifer serve individual public water systems and supplements the MDWS Upcountry system. Irrigation wells pump about 0.16 mgd mostly brackish water and are densely installed throughout Spreckelsville. Following cessation of sugarcane cultivation, the withdrawals from Pā`ia aquifer has decreased from 29 mgd to 0.4 mgd. The Hamakuapoko wells at 700 foot elevation serves the MDWS Upcountry system during droughts. The contaminant 1,2-Dibromo-3-chloropropane, or DBCP, detected at the wells is treated using Granular Activated Carbon (GAC) filtration. By deducting the production capacity of Hamakuapoko wells, the remaining sustainable yield can potentially be developed for non-potable supply in the region from Pā`ia-Kuau to Pu`unene. Because chemical contaminants in the Pā`ia Aquifer are an issue, potable well development would need to

consider the investment and cost of GAC treatment and possibly additional treatment for nitrates.

Planned Growth Areas Upcountry

Table 15-25 show nine projects Upcountry, totaling 0.89 - 2.75 mgd. Although all planned growth areas Upcountry could theoretically be served by the MDWS Upcountry System, all development is subject to the Upcountry Meter Priority List. It is assumed that the planned additional 1491 housing units is accounted for by population growth and the 2014 Socio-Economic Forecast. The WUDP does not analyze individual projects status on the Meter Priority List but private source development will likely be required for some of the large projects, such as Haliimaile, Pukalani Expansion and Pukalani Makai. Whether projects are served by private or the MDWS Upcountry system, source development is needed to meet municipal demand.

Most of planned growth Upcountry is located in the Makawao aquifer with a sustainable yield of 7 mgd. The aquifer is relatively undeveloped, primarily due to the high cost of construction and pumping wells at over 1,000 foot depth. There are limited hydrological studies of the aquifer but existing wells generally have good water quality and productive yield. Basal water can provide potable supply to meet demand and contingency needs Upcountry.

Planned Growth in Kama`ole Aquifer

Planned growth from Maalaea to Makena is with few exceptions within the MDWS Central System and addressed in the Wailuku ASEA Report, Chapter 14. Planned growth above 1,000 foot elevation is generally within the MDWS Upcountry System area. Brackish groundwater occurs regionally at lower elevations. Known chloride levels for irrigation wells throughout the aquifer range from 100 to over 1,400 mg/l. Installed pump capacity in the Kama`ole aquifer is 18.8 mgd. The sustainable yield established by CWRM is 11 mgd. Reported pumpage for irrigation purposes is 2.82 mgd for 2014/2015. Pumpage is reported from 26 of 75 installed irrigation wells. Additional pumpage is assumed to occur from Kama`ole aquifer beyond the 35% of installed irrigation wells that report to CWRM. CWRM well data indicate lower chloride levels in wells above 500 foot elevation but still above 200 mg/l. Densely spaced irrigation wells along the shoreline are subject to rising sea-levels and associated saltwater intrusion. It is anticipated that chlorides will increase in existing wells along the south shore coastline.

Few wells have been developed at higher than 400 – 500 foot elevation and chloride levels are unknown. Additional yield may be developed at 1000 foot elevation and higher in the Keokea region where chloride levels are assumed to be within potable range. Withdrawals below 500 feet to serve planned growth in the coastal area would require additional treatment to remove chlorides, such as reverse osmosis. Remaining yield cannot be determined until improved

reporting and water use data is available, but it is assumed that existing wells can continue to provide current levels of non-potable irrigation supply of about 3 mgd in the Ma`alaea, Kihei, Wailea and Makena areas.

15.7.3 Alternative Sources within the Central Aquifer Sector Area

Planning objectives identified in the public process and in the Community Plans support increased use of recycled water, promoting the highest quality water for the highest end use, and to protect and prioritize public trust uses in allocating groundwater in regions of limited resources and conflicting needs. Recycled water is available in Kahului, Kihei, Makena and to a limited amount in Pukalani. There is no municipal wastewater treatment facility Upcountry where development generally is served by individual septic systems and cesspools. There is no existing stormwater collection facility in the Central ASEA.

Recycled Water

Upgrade of the Wailuku-Kahului wastewater reclamation facility (WWRF) from R-2 to R-1 production could offset about 3 mgd of diverted stream water or pumped groundwater for non-potable irrigation. The Department of Environmental Management's fiscal year 2018 capital improvement program budgeted $0.5M for design of a new water distribution line connecting the Kahului WWRF to an existing line at the old Maui Pineapple processing facility. The project budgeted $6.2M for construction in fiscal year 2020 that would make R-1 water available to the HC&S fields east of Kuihelani Highway, currently served by East Maui stream diversions through the East Maui Irrigation Company distribution system. This project is temporarily on hold. An analysis of irrigation system service areas and the HC&S Diversified Agricultural Plan, the R-1 project could benefit fields served by Na Was Eha surface water, brackish water but not EMI ditch water. The project is not accounted for as available supply to meet demand in Table 14-38 until R-1 water is produced at the WWRF. Strategy #8 in the Wailuku ASEA Report recommends expanding distribution for additional supply of up to 4.2 mgd.

The Kihei WWRF serves the South Maui area from Wailea to Sugar Beach. R-1 supply of 1.5 mgd is currently used with an additional 0.7 mgd available to off-set potable water on the MDWS Central System. The R-1 supply is included in Table 14-38 and Strategy #9 of the Wailuku ASEA Report.

The private Makena WWRF was using about 0.08 mgd of R-1 for golf course irrigation of a 0.75 mgd production capacity. The facility is under redevelopment and is assumed to provide at least 0.08 of non-potable supply but will be reassessed in future WUDP update for additional supply.

The Pukalani WWRF uses about 0.19 mgd of R-1 water produced for non-potable irrigation. Use represents 65 percent of design capacity and is not assumed to increase.

15.7.4 Surface Water Imports from Ko`olau Aquifer Sector Area

Since the WUDP chapter for the Ko`olau ASEA was published for review, CWRM issued their decision in the Contested Case over East Maui Streams and established Interim Instream Flow Standards (IIFS). For the purpose of assessing available surface water for off-stream uses in the Central ASEA, we have attempted to calculate stream flow under various conditions that would be available to divert after meeting established IIFS, based on the June 20, 2018 Findings of Fact, Conclusions of Law and Decision and Order (FoF, CoL and D&O) for the East Maui streams contested case. The following are key findings as it relates to water import from Ko`olau ASEA for agricultural use in Central ASEA:

1. Planned future uses of A&B/HC&S lands as set forth in the Diversified Agriculture Plan is consistent with the use of lands designated Important Agricultural Lands (IAL).
1. Water requirement forecasts for the plantation continue to evolve and will vary with crop rotations, agricultural methods, planted acreage and urban growth.
2. Not all of projected irrigation water needs under the Diversified Agriculture Plan will be met based on median base flow from the streams that can continue to be diverted
3. Brackish groundwater is expected to provide some portion of the Diversified Agricultural Plan water needs.
4. It is expected that a sufficient amount of water would be available (after meeting IIFS) to provide the initial phase of IAL designated lands to be developed for diversified agriculture.
5. A&B/HC&S shall report on crops and acreage planted and changes in the Diversified Agriculture Plan
6. It is A&B/HC&S' responsibility to allocate the water it may get under a lease from the Board of Land & Natural Resources (BLNR) between irrigation water and system losses.
7. CWRM continues to allow some streams to be diverted, which includes freshets and stormwater. The BLNR may continue to license diversions of water that is not needed to meet the adopted IIFS.

While the Hearing Officer's January 2016 and July 2017 Proposed FoF, CoL and D&Os stated the amount of water to be returned to the streams, the June 2018 decision does not. A&B/HC&S would be able to divert water through the EMI system from some of the streams subject to the contested case. In comparing established IIFS and base flow at various conditions, 20.35 mgd would be available from the streams subject to the contested case as base flow during median flow conditions (Q50) to potentially divert through the EMI system. About 8 mgd would be available from the streams west of Honopou streams through Maliko Gulch. Therefore about 28 mgd would potentially be available from Wailoa Ditch for use at Kamole Weir for MDWS, to Kula Ag Park and for A&B/HC&S diversified agriculture. However, because freshets and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions.

About 17.84 mgd of brackish groundwater could reasonably be used to supplement surface water, as interpreted in the June 2018 decision. Total available water would then be about 46 mgd.

During low flow conditions, or Q90, only 2.21 mgd appears to be available for A&B/HC&S to divert after satisfying IIFS. Because IIFS are monitored on a 12-month moving average basis, any "overdraft" during short periods of droughts may not violate adopted IIFS. It is recognized that requiring a specific amount of stream flow at all times at a specific location is incompatible with the objectives. [65] However, it's clear that the June 2018 Decision does not provide for sufficient diversions during extended droughts to meet proposed demand under the Diversified Agricultural Plan. The table in Appendix 15 A attempts to summarize IIFS and assess available water to divert for offstream uses.

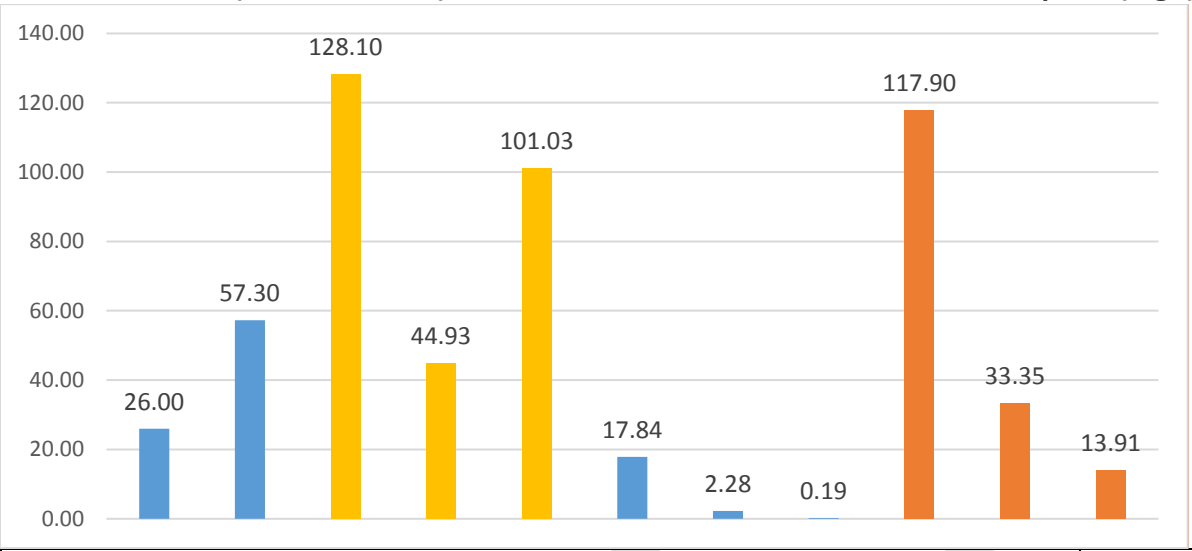
The chart below shows resources within the Central ASEA, resources in Ko`olau ASEA that were used in the base year 2014 to serve water use in the Central ASEA and estimated surface water resources available according to the June 2018 CWRM decision. The chart also shows brackish groundwater that was available to pump in 2014, based on reported pumpage. Available brackish groundwater above natural sustainable yield is not known. A hypothetical available yield is provided based on the CWRM June 2018 Decision's reasoning where historically 20 - 30 percent of total use was groundwater.

Recycled water available in South Maui includes 1.5 mgd currently used and an additional 0.7 mgd available from the Kihei Wastewater Reclamation Facility (WWRF) and 0.08 mgd from the Makena WWRF. Recycled water available in the Upcountry region is 0.19 mgd at the Pukalani WWRF.

Estimated surface water "available to divert", is hypothetical with the understanding that off-stream uses have not been quantified or qualified. A&B/HC&S uses are subject to the Board of Land & Natural Resources allocations of land leases. MDWS use from the Wailoa Ditch requires an allocation agreement with A&B Properties.

[65] CWRM, June 20, 2018 Findings of Facts, Conclusion of Law and Decision and Order, CCH MA13-01

Figure 15 -27 Population Mid-Growth Based 20-Year Water Demand Projections and Available Water Resources (2014 and 2018), Central ASEA and Ko`olau Surface Water Imports (mgd)

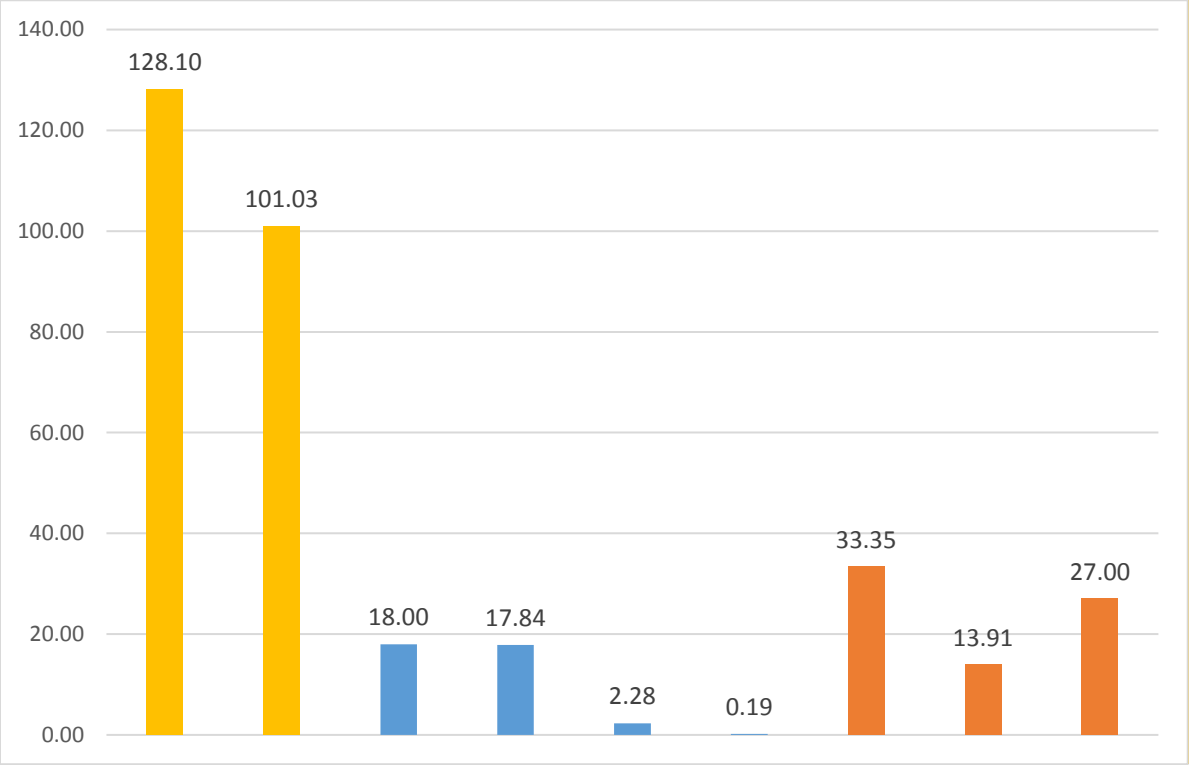


Groundwater Sustainable Yield	26.00
Pā`ia and Kahului Brackish GW Available in 2014	57.30
DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land use based AG and DHHL (excl. MDWS Central System)	**128.10**
Demand Pop. Mid-Growth CENTRAL ASEA hydrologic unit only	44.93
Demand AG only	101.03
Pā`ia and Kahului Brackish GW Potentially Available 2035	17.84
R-1 Water Kihei and Makena Region (MDWS Central System Service Area)	2.28
R-1 Water Pukalani (MDWS Upcountry Service Area)	0.19
Ko`olau Surface Water Imports, 2014	117.90
Ko`olau Surface Water Available to Divert at Median Flow (Q50), less IIFS, 2018	33.35
Ko`olau Surface Water Available to Divert at Drought Flow (Q90), less IIFS, 2018	13.91

15.7.5 Groundwater Imports from Ko`olau Aquifer Sector Area

Sources for the MDWS Upcountry System includes two wells in the Ha`ikū aquifer of the Ko`olau ASEA: Ha`ikū Well, which produces about 0.5 mgd, and Kaupakalua Well producing about 0.9 mgd. The Ha`ikū aquifer is relatively undeveloped, with 0.82 mgd (less than 3 percent) total pumpage of established sustainable yield. The chart below shows the Central ASEA and Ko`olau Surface Water Resources assumed available in 2018 (excluding 2014 imports from the figure above), with the addition of Ha`ikū aquifer sustainable yield. It is noted that a portion of Ha`ikū aquifer is proposed to be explored to meet potable demand on the MDWS Central System per Chapter 14.8.

Figure 15 -28 Population Mid-Growth Based 20-Year Water Demand Projections and 2018 Estimated Available Water Resources, Central ASEA, Ko`olau Surface Water and Groundwater Imports



DEMAND Pop. Mid-Growth, incl. MDWS Upcountry System, Priority List, Land use based AG and DHHL (excl. MDWS Central System)	**128.10**
Demand AG only	101.03
Makawao and Kama`ole GW Sustainable Yield	18.00
Paia and Kahului Brackish GW Potentially Available	17.84
R-1 Water Kihei and Makena Region (MDWS Central System Service Area)	2.28
R-1 Water Pukalani (MDWS Upcountry Service Area)	0.19
Ko`olau Surface Water Available to Divert at Median Flow (Q50), less IIFS, 2018	33.35
Ko`olau Surface Water Available to Divert at Drought Flow (Q90), less IIFS, 2018	13.91
Ko`olau GW Sustainable Yield	27.00

15.8 Strategies to Meet Planning Objectives

The WUDP update public process generated a set of planning objectives through an iterative process. Multiple resource options to meet planning objectives and projected demand were reviewed and evaluated in regional public meetings and workshops to assess constraints, relative costs, implementation risk and viability[66]. Planning objectives, preliminary strategies and related material reviewed in the final public workshop, November 29, 2016 is attached as Appendix 13. The selected strategies are presented below along with available cost estimates, hydrological, practical and legal constraints, opportunities and risks that were considered in assessing the viability of a specific resource or strategy. Life cycle costs are estimated for conventional and alternative resource strategies where engineering studies and reports were available, including capital, operation and maintenance costs per 1,000 gallons supply.

Key issues identified for the Central ASEA, which includes Central, South and Upcountry Maui communities and water resources within the Ko`olau ASEA, relate to managing the development and transportation of water from areas with abundant rainfall to areas with scarce rainfall and subsidizing infrastructure in water scarce areas, maintenance of traditional resource management using the ahupua`a system and ensuring that traditional and customary practices are safe guarded. Much of the public water use in the Central ASEA relies on Ko`olau surface water resources conveyed via privately owned transmission systems. A key issue for the region is providing affordable water for future needs, providing for public trust uses, farming Upcountry and on the Central Maui isthmus during droughts, and managing resources in a sustainable way.

Recommended alternatives include resource management as well as development of conventional and alternative resources. All strategies are assumed to include conservation consistent with recommended supply and demand side conservation strategies outlined in Section 12.2. Recommendations should guide resource use and infrastructure development over the 20-year planning period. Estimated timeframes for implementation are indicated, allowing for flexibility to re-scope, prioritize and adjust to available funding.

15.8.1 Resource Management

Planning objectives related to resource management identified and confirmed in the WUDP update public process, the Maui Island Plan (MIP), the Paia-Haiku Community Plan, the Makawao-Pukalani-Kula Community Plan and the Wailuku-Kahului Community Plan include:

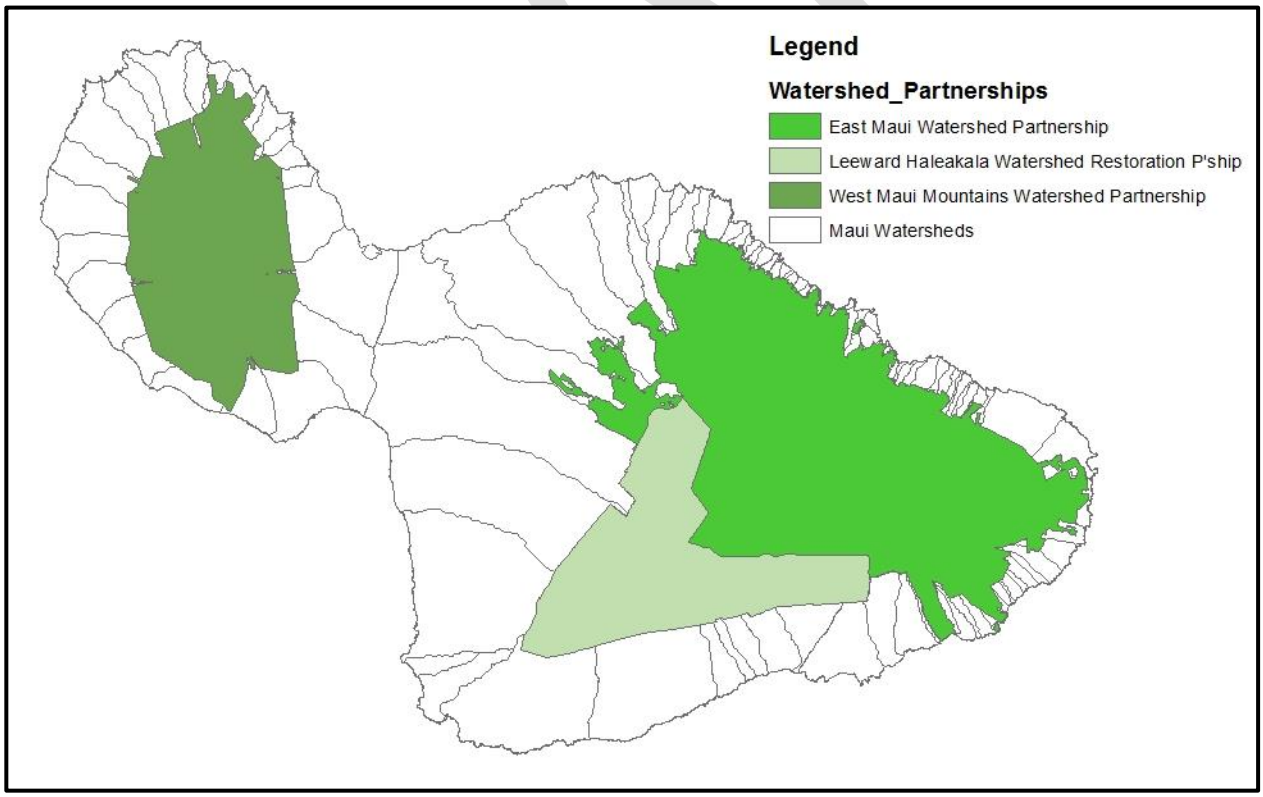
- Watershed protection and its prioritization is important, including invasive alien plant control, ungulate control, and reforestation via watershed partnership programs.
- Build up what is taken from aquifers

[66] Preliminary Strategies for Central Sector (Upcountry) November 30. 2016

Watershed Protection

Issue and Background: Most land within this hydrologic unit are water resource "import" areas, rather than "export" areas in the sense that population and agricultural operations rely on water resources from adjacent watersheds. Watershed management in both types of watersheds are important. The Department of Land and Natural Resources has identified "Priority Watershed Areas" which are areas of highest rainfall and resupply, based on climatic conditions that provide high recharge and fog capture. Currently protective measures are focused in these priority areas above the 3,000 foot elevation with direct benefit to makai lands and the nearshore environment. The East Maui Watershed Partnership (EMWP) manages most of the forested upper critical watersheds of Ko`olau aquifer sector. Ongoing efforts include ungulate control through fence construction, retrofitting and regular trap checks weed management, monitoring, and human activities management through outreach and education. On the dry side of Haleakala, the Leeward Haleakala Watershed Restoration Partnership (LHWRP) works towards restoring the disturbed landscape where once dryland forests captured rain and fog that recharged the freshwater supply. The Maui Invasive Species Committee (MISC) targets pest animals and plant species to prevent their influx and establishment in the mauka critical watersheds. Their efforts occur throughout the Central ASEA in rural and agricultural regions as needed.

Figure 15-29 Watershed Management Partnerships and the Central Aquifer Sector



The Makawao-Pukalani-Kula Community Plan states as objectives:

- Recognize the importance of the forested watershed areas and that their health and well-being are vital to all the residents of the Upcountry area.
- Explore a comprehensive reforestation program to increase and catch more rainwater for the Upcountry area.

The objectives support the ongoing efforts by EMWP, LHWRP and MISC. State and county agencies as well as private purveyors can provide financial support and participation in watershed protection partnerships and reforestation programs. Strategies for watershed management in Ko`olau is addressed in the Ko`olau ASEA Report, Chapter 16.8.1. Management efforts on leeward Haleakala is addressed in the Kahikinui ASEA Report, Chapter 18.8.1.

Exercise of Traditional and Customary Rights in the Central ASEA

Issue and Background: The outreach to community groups and organizations with knowledge about traditional and customary (T&C) uses did not yield site specific information to consider in the Ka Pa`akai analysis. In order to identify traditional and cultural resources, anticipate impacts, and protect native Hawaiian rights, MDWS consulted the Maui Aha Moku Advisory Committee, which possesses knowledge of persons who may be consulted on these issues. The Maui Island Aha Moku (Moku O Pi``ilani) was also consulted and has been actively engaged in the WUDP process. During meetings with the Water Committee of Moku O Pi`ilani and members of Wailuku, Kula, Honua`ula and other mokus, strong support was voiced for initiating and implementing a native Hawaiian consultation process for the WUDP. The consultation implies two-way communication and influence between agencies and stakeholders. Representatives of the Kula moku (in the Central ASEA) were active participants in development of the WUDP and invited MDWS representatives to participate in their regional moku meetings. The intent is for the consultation process to continue as new site specific source development and resource use projects are developed.

Water Quality

Issue and Background: Contaminants primarily from many urban and agricultural land uses pose a risk to freshwater supplies. Atrazine is an herbicide associated with sugarcane cultivation that is detected in irrigation wells in the Paia and Kahului aquifers. Herbicides that were used decades ago in pineapple cultivation is still detected in Paia aquifer wells. As new sources are developed to meet projected demand, it is important to consider current and historic land uses of the underlying aquifer to avoid contamination of wells and associated treatment costs. Well siting and wellhead protection are addressed under island-wide strategies #6 “Implementing well siting criteria to avoid contaminated groundwater supplies and unnecessary risks to public health” and #7 “Adopt wellhead protection measures for potable wells.”

15.8.2 Conservation

Input from the WUDP public process and issues identified in the community plans relate to water shortages and conservation:

- Reliance on surface water Upcountry makes the system vulnerable to drought conditions
- Voluntary and mandatory water use restrictions imposed on residential and agricultural users during droughts often negatively impact the productivity of farmers
- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Provide incentives for water and energy conservation practices.
- Promote energy conservation and renewable energy.
- Incorporate drought-tolerant plant species and xeriscaping in future landscape planting.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Per capita water use decreased
- Potable and irrigation systems water loss decreased
- Community water education increased
- Incentives for water conservation increased
- Renewable energy use increased

Issue and Background: The recommended supply and demand side conservation strategies outlined in Section 12.2 apply island wide. Development projects in the Central ASEA represent about 8.4 mgd, not accounting for projects located in the Wailuku ASEA. A large portion of the demand is for irrigation of single family home landscaping and common areas. Outdoor use is generally higher in Kahului, Maalaea, Kihei and Makena. These areas are dry microclimates with less than 15 inches of rainfall per year. There is great potential for further conservation targeting residential and commercial irrigation using potable water supply.

The Upcountry region has experienced voluntary and mandatory conservation measures for decades, primarily in dry season when the MDWS Upcountry System reservoir levels are low. Reliance on surface water and constraints in developing additional groundwater causes the system to be vulnerable to droughts.

Demand Side Conservation Measures

Demand side conservation strategies recommended in Section 12.2 that would target outdoor uses of potable water include comprehensive water conservation ordinance to include xeriscaping regulations, landscaping and water efficient irrigation system incentives.

In evaluating cost-effectiveness, MDWS compared the costs to develop and deliver new sources of water to meet future demand with the savings attributed to conservation. A preliminary analysis of the proposed conservation measure portfolio outlined in Section 12.2 shows that doubling current investments (MDWS annual FY14 – FY17 conservation budget, excluding leak detection is $170,000) would result in net capital and operational savings. The potential for a net savings is expected for both the MDWS Central System and the Upcountry System due to the need for new source development.

Recommended demand side conservation measures at all levels and type of use for public water systems are outlined in table 13-1 (strategies # 10 – 25). There is an opportunity to design and implement conservation measures in new housing development throughout planned growth areas. The recommended conservation Strategies #17, 22 and 25 outlined in Table 13-1 are implemented in the design and build phase and are especially appropriate in planned growth areas:

- Revise county code to require high efficiency fixtures in all new construction. Develop a comprehensive water conservation ordinance to include xeriscaping regulations.
- Revise County Code: Water conserving design and landscaping in new development (xeriscaping targets dry areas).
- Revise County Code and/or incentivize water- efficient building design that integrates alternative sources (grey water, catchment).

Supply Side Conservation Measures

The sustainable and efficient use of water resources, as well as the capacity and integrity of water systems, can be improved by accounting for water as it moves through the system and taking actions to ensure that water loss is prevented and reduced to the extent feasible.

A water audit provides a data driven analysis of water flowing through a water system from source to customer point-of-service and is the critical first step in determining water supply efficiency and responsible actions to manage and reduce water loss consistent with available source, operational and financial resources.[67]. Comprehensive audits for all MDWS systems are performed annually. Public water systems serving a population of 1,000 or more and those within water management areas regardless of population served are required to submit annual water audits beginning July 1, 2020. Except for the MDWS systems, there are no large public water systems in the aquifer sector subject to the requirement. The fiscal year 2017 audit for

[67] USEPA. Using Water Audits to Understand Water Loss. A Joint Presentation of the USEPA Office of Groundwater and Drinking Water and the American Water Works Association, 1/26/2012. https://www3.epa.gov/.../waterinfrastructure/docs/water-audits_presentation_01-2012.pdf *Accessed March 29, 2017.*

the Upcountry system revealed that apparent water losses are often due to data gaps between the amount of water withdrawn at the source, treated, stored and billed. The results will guide MDWS data collection, maintenance and repair programs. Part II Strategy # 28 addresses water system maintenance and operations to minimize sources of water loss.

Agricultural Water Systems Water Loss Mitigation

Issue and Background: The East Maui Irrigation (EMI) System is the only conveyance infrastructure of Ko`olau ASEA surface water to agricultural uses in Central Maui. Public concerns were voiced over the EMI system falling into disrepair, inefficiencies due to unlined storage reservoirs and system losses. In the East Maui Streams Contested Case, system losses were assessed to about 22 percent. As sugarcane cultivation is transitioned to other uses, EMI continues to maintain the system and keeping the main ditches functional even with reduced volume flow. CWRM in its June 2018 decision encourages HC&S to seek to make its storage and delivery of water to its fields more efficient to increase the productive yield of the irrigation water from East Maui. Raw water storage reservoirs are subject to state rules established by the State Department of Land and Natural Resources and stricter insurance requirements. The liability and associated costs impede refurbishment of privately owned reservoirs.
Any major infrastructure upgrades will require creative funding such as private-public partnerships with county or state contributions. The current county administration is considering pipe installation in unlined ditches and county ownership of the system. The island wide Strategy # 35 in Chapter 12 is further defined to apply to the EMI system:

Strategy # 1: Explore funding and conduct a cost benefit analysis of improvements to the EMI non potable conveyance system to mitigate losses and preserve existing reservoirs at risk of decommissioning. County of Maui and A&B Properties/EMI Company in partnership would lead initiatives. Priority components and associated costs TBD.

15.8.3 Conventional Water Source Strategies

Conventional water sources include groundwater (wells and tunnels) and surface water (stream diversions).

Planning objectives related to groundwater and surface water source use and development identified in the WUDP update public process include:

- Manage water equitably
- Provide for Department of Hawaiian Homelands needs
- Provide for agricultural needs
- Protect cultural resources
- Provide adequate volume of water supply
- Maximize reliability of water service
- Minimize cost of water supply

Planning objectives and policies related to water availability and use identified for the region include:

- Coordinate water system improvement plans with growth areas to ensure adequate supply and a program to replace deteriorating portions of the distribution system. Future growth should be phased to be in concert with the service capacity of the water system.
- Coordinate the construction of all water and public roadway and utility improvements to minimize construction impacts and inconveniences to the public
- Coordinate expansion of and improvements to the water system to coincide with the development of residential expansion areas.
- Adequate water supply to support Upcountry agriculture.
- Priority for available water (Upcountry) is agriculture and DHHL

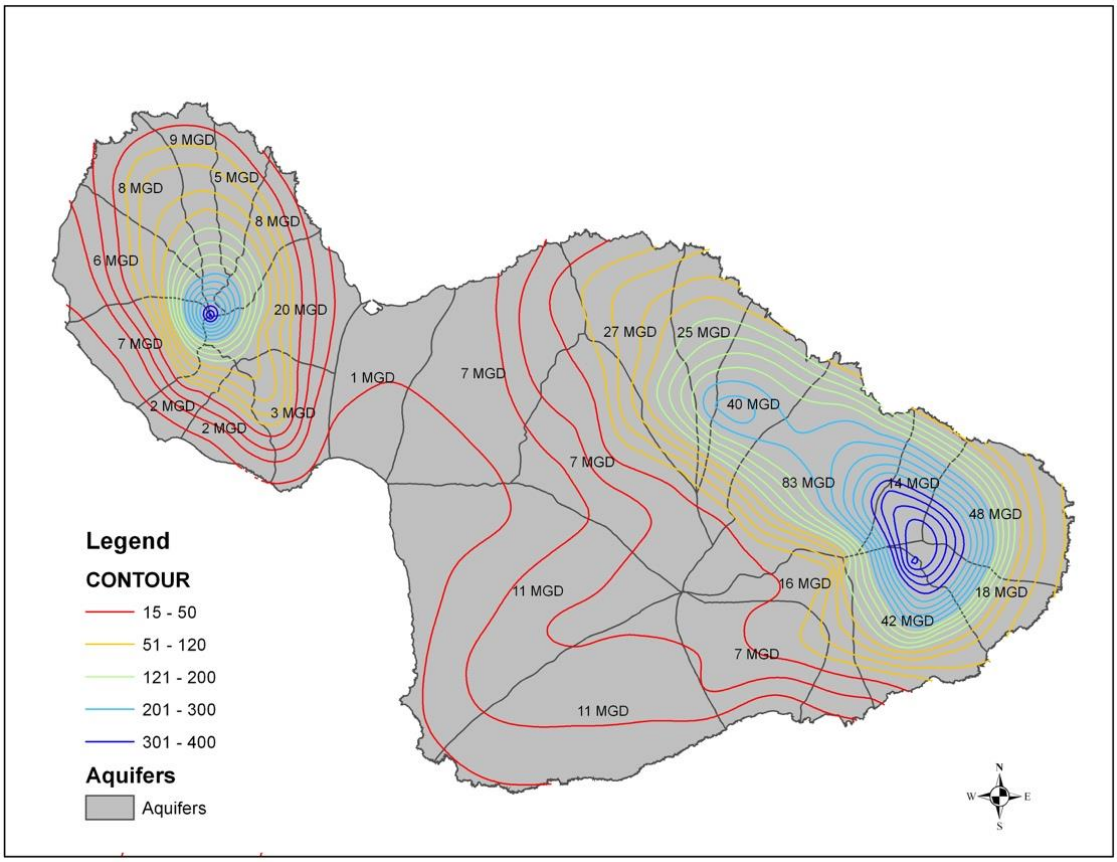
Groundwater Availability Issues

The amount of groundwater that can be developed is limited by the amount of natural recharge and aquifer outflow that contribute to streamflow and to prevent seawater intrusion, established as sustainable yield. Because delineation of aquifer sectors and systems in some cases are based on limited hydrologic information, areas for potential groundwater development must be assessed to determine whether there is a need to conduct hydrologic studies or whether there is adequate information available to develop new water supplies. The primary responsibility to determine interaction with surface water and other sources lies with the State CWRM who in turn relies on studies and predictions by the scientific community and other agencies. Water purveyors need guidance how to mitigate and adjust to potential changes in groundwater availability.

Other constraints on groundwater availability include access and cost. Conveyance from high yield aquifers in remotely located watersheds to growth areas can be difficult and expensive due to topography and distance. The Central ASEA consist of the driest regions on Maui, with

annual rainfall generally less than 50 inches. Population centers and growth rely on groundwater imports from the Wailuku ASEA and the Ko`olau ASEA where rainfall and groundwater recharge are substantially higher.

Figure 15-30 Rainfall Isohyets (inches per year) and Aquifer System Sustainable Yields



Infrastructure Availability Issues

Residents believe a water availability rule is critical to maintain water availability in a sustainable fashion. The County Availability Rule, Maui County Code Section 14.12 applies to the MDWS systems. The rule only addresses residential developments. On January 28, 2018 the MDWS adopted administrative rule 16-201 with the purpose to provide uniform handling of applications for water service. The rule applies to all MDWS systems, except the Upcountry system. The administrative rule resolves some of the loop holes and concerns associated with the County Availability Rule Chapter 14.12. The MDWS Upcountry System is subject to the Water Meter Issuance Provisions codified in Chapter 14.13 of the County Code.

The Upcountry Priority List

Issue and Background: In 1993, the MDWS determined that the existing Upcountry water system was found to have insufficient water supply developed for fire protection, domestic and irrigation purposes to add new or additional water services without detriment to those already served.

MDWS created a list of Upcountry properties, by date of application, who requested new and additional water service. In 2002, an administrative rule "Water Meter Issuance Rule for the Upcountry Water System", Title 16, Chapter 106 was created. The rule outlined the procedure for processing applications for water service. New applicants were continually added to the list until provisions were codified in 2013 so that no new applications were accepted after the 2013 provisions became effective. A 2015 ordinance provided certain fire protection exemptions. Still, about half of meter offers are declined presumably due to the expense of required system improvements. The Priority List is estimated to represent an additional 3.7 – 7.3 mgd demand on the Upcountry system as a whole. There are about 1,800 requests for 4,300 meters (excluding those that did not accept a reservation offered, accepted a reservation, or where a meter was installed) for 1,900 dwelling units and a nominal number of commercial units. About two-thirds of the remaining requests are located outside designated growth areas. There remains uncertainty over the number and timing of new meters as well as occupancy.

Sources for requests in Haiku are primarily served by basal wells with sufficient backup capacity to reliably add new services. Sources for requests on the Lower and Upper Kula subsystems are East Maui streams in the Waikamoi area that are subject to Instream Flow Standards and vulnerable to drought. Groundwater from Po`okela Well in Makawao aquifer can supplement the Lower and Upper Kula subsystems. There remains uncertainty over the number and timing of new meters as well as occupancy.

Providing reliable capacity to satisfy the Priority List could be accomplished in alternative ways:

1. Develop basal wells to provide reliable capacity and assume significantly higher cost of service due to energy required to pump up to 4,000 foot elevation
2. Separate the Priority List by service area and source, so that subsystems with adequate and reliable capacity are prioritized over subsystems reliant on surface water.
3. Public-private partnerships to develop source and infrastructure that benefit end users of the same subsystem.

Altering the priority list processing would require code changes and would without doubt cause opposition by applicants that would not benefit from such changes. The recommended strategy is assessing the various options of restructuring and processing the list while moving forward with needed source development.

Strategy #2: Assess alternative options to restructure and process the existing Upcountry Meter Priority List to improve processing rate and adequate source development. Lead agency is MDWS.

<u>Groundwater Development to Meet Population Growth</u>

Issue and Background: Groundwater resources will meet most of the potable demand that is served by the MDWS Central System. Source development needs for this system was addressed in the Wailuku ASEA Report. Remaining potable demand in the Central ASEA is either served by small privately owned systems or the MDWS Upcountry System.

Private municipal demand and Department of Hawaiian Homelands (DHHL) potable demand in the Kahului aquifer, totally projected to about 2.09 mgd can probably be met with modest groundwater withdrawals from Kahului, Paia and Kamaole aquifers. DHHL potable demand in the upper Kamaole aquifer (Keokea/Waiohuli) of 0.81 mgd may be met with Kamaole aquifer groundwater or the MDWS Upcountry System.

The table below compares the following:

1. Installed pump capacity, which includes backup wells and unused capacity, and rated surface water treatment plant capacity.
2. Source Capacity, limited by water system standards
3. Projected municipal water use in Central ASEA and the "lower" Kamaole Aquifer; the "upper" Kamaole aquifer which excludes the MDWS Upcountry System.
4. Projected demand for the MDWS Upcountry System and the Upcountry Meter Priority List

Table 15-35 Groundwater Source Development to Meet Population Growth Based Municipal Demand - Central ASEA and the MDWS Upcountry System 2035 (mgd)

Aquifer System (Sustainable Yield)	**Installed Pump Capacity**	**Source Capacity***	**2035 Municipal Demand**
Kahului (1)**	1.58	0.84	2.09
Paia (7)	0.216	0.216	
Kamaole (11)	0.86	0.43	
	0.00	0.00	0.81
Subtotal Central Excl. Upcountry System	**2.66**	**1.50**	**2.90**
Paia (7)	1.65	1.5	8.53
Makawao (7)	1.85	1.3	
Haiku (27)	2.61	1.4	
Surface Water Treatment Plant Capacity	13.00	7.00	
Upcountry Meter Priority List			7.3
Unmet needs			**-4.63**
Upcountry System and Priority List	**19.11**	**11.2**	**15.83**

Source: MDWS Water Resources & Planning Division, 2018. Numbers may not add up due to rounding
*Water System Standards/Contingency wells
**excl. Maui Lani wells, serving MDWS Central System

As shown in the table, groundwater source development and/or surface water imports are needed to meet population growth based municipal needs and the Upcountry Meter Priority List. Upcountry Maui (Kula, Makawao and Pukalani) that rely on surface water are particularly at risk to drought and its' impact on water supply. Although technically feasible, development of sufficient new basal wells to meet 100% of projected demand in the MDWS Upcountry system along with booster pumps, the high capital and pumping costs makes this option economically less desirable. A preferred option is to operate ground and surface water

resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[68] Haiku and Makawao aquifers are preferred options based on available yield, elevation and connection to the existing distribution system.

Source Development for the MDWS Upcountry System

Recent amendments to the Interim Instream Flow Standards (IIFS) on East Maui streams results in decreased base flows in the Wailoa Ditch which is the source of water for the Kamole Water Treatment Facility (WTF). Even with decreased off stream needs in the transition from sugarcane cultivation to diversified agriculture, water shortage in droughts will likely continue as long as the system relies on surface water as the primary source. Typically, during drought conditions, average daily demand per user increases. Peak demand for projected needs must therefore be accounted for to ensure reliable supply. The potential demand of fulfilling 100 percent of the Upcountry Meter Priority List is conservative as historically about 50 percent of meter applications on the List result in meter installations. Hence, peaking demand is only factored into projected demand based on population growth: 8.53 mgd. In a 2013 MDWS Study to Determine the Source Capacity of the Existing Water System peak daily demand for the system was identified as 11.6 mgd. [69] A "peaking factor" of about 20% is added in calculating source development needs.[70] Actual peak demand is calculated in the engineering analysis for an individual well site, pump size and service area.

In the 2013 study, the reliable capacity of the Upcountry System was determined to be 9.7 mgd. Adding the Hamakuapoko wells in Paia aquifer of 1.5 mgd source capacity, the reliable capacity is 11.2 mgd, as shown in the table above.

Adding 20% to projected 2035 demand of 8.53 mgd for Upcountry is 10.23 mgd. With the addition of the Priority List demand of 7.3 mgd, total demand is 17.54 mgd. Available source capacity is 11.2 mgd, which would require the balance 6.34 mgd to be developed.

8.53 mgd 2035 Municipal Demand + Peak Factor 20% = 10.23 mgd
+ Upcountry Meter Priority List 7.3 mgd = 17.54 mgd
- 11.2 mgd Available Source Capacity
= 6.34 mgd Source Needed

Assumptions in the 2013 MDWS study were 50 percent of applicants on the List declining water meters due to the cost of required improvements or other reasons. Since the 2013 study,

[68] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update
[69] MDWS, 2013 Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas
[70] MDWS, 2013 Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas

amendments to the County Code have eased the financial burden on applicants which potentially could result in a higher percentage of meter acceptance.

A combination of increased source using the Hamakuapoko wells, increased use of boosting surface water from to maintain raw water reservoirs levels at the Piiholo and Olinda water treatment facilities will support increased demand to a certain degree. New ground water source capacity will need to be developed to provide reliable service over the 20-year planning period. Preliminary groundwater source strategies for Upcountry included two candidate aquifer systems: Makawao and Haiku.

Makawao Aquifer Well Development

Hydrological studies of Makawao aquifer are limited. The State Department of Land and Natural Resources are currently developing a well in the Hanamu area at about 2,000 foot elevation. The existing MDWS Po`okela well at 1,820 foot elevation produces excellent water quality. With the addition of Po`okela Well B as a backup well, the primary well can be utilized permanently adding reliability to the system. Pumping deep wells (near sea level) to the high elevation and further boosting the water uphill to service areas involves higher electrical power consumption. In addition to high pumping cost, the depth of well pumps adds some complexity to development and maintenance. Historic pineapple cultivation has resulted in chemical contamination of certain areas of the aquifer. Well development upgradient of former pineapple fields increase pumping costs. Areas suited for well development and connection to existing infrastructure would not likely support the full source needs of 6.34 mgd. The 2013 MDWS study estimated well development at 2,050 foot elevation and related booster pump and transmission line to about $8.4M and a 20-year cost of $2.90 per 1,000 gallons for development of 1.2 mgd pump capacity, normally run at 0.8 mgd source capacity. The study only evaluated a scenario with one well in Makawao aquifer and in combination with well development outside Makawao aquifer.

Strategy #3: Explore new basal well development in the Makawao aquifer to accommodate growth Upcountry and add reliable new source. Potential yield is up to 3 mgd. Lead agency is MDWS, DLNR and/or public/private partnerships.

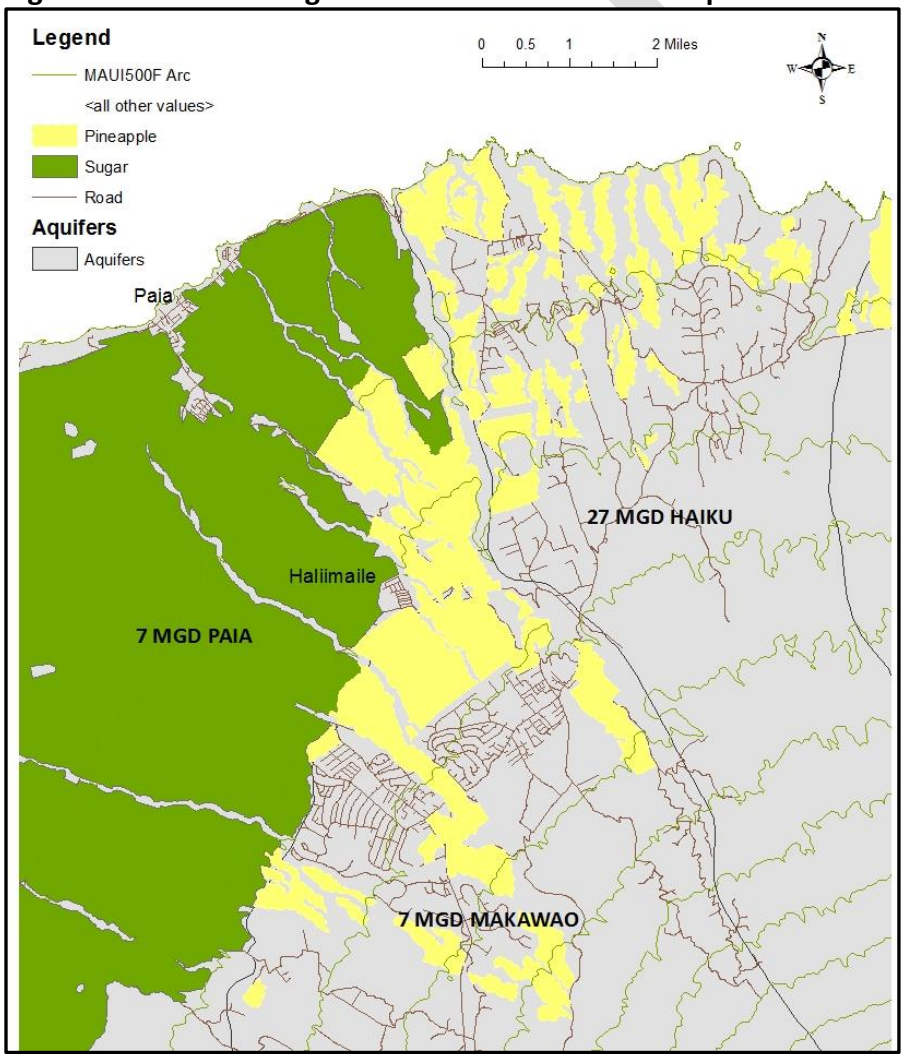
Haiku Aquifer

The Haiku aquifer sustainable yield is sufficient to provide new basal groundwater well development. Subsequent to the 1990 WUDP, long range water development plans included well exploration in the Paia and Haiku aquifers. The plans were stopped by lawsuits raising claims about impact on stream flows. The 2003 Consent Decree essentially put a halt to groundwater development in the subject area. The plaintiffs in the case allowed only phase 1 of the East Maui Water Development Plan to be implemented, which included the Hamakuapoko wells, located in the Paia aquifer. Since 2003 there have been multiple assessments and cost benefit analyses conducted to explore groundwater development outside the Consent Decree

area in the Haiku aquifer and alternative options. Various configurations of eastward basal groundwater development were assessed in the 2004 – 2009 WUDP Upcountry DWS District Plan update. Well at 1,300 foot elevation and 1,800 foot elevation were explored. Booster pump upgrades were assumed to be installed as necessary to move water to higher elevations.

Well development and transmission from Honopou and Waikamoi aquifers were not considered as candidate strategies in the 2007 or the 2016 public process. In examining the economics of well and transmission installation at various elevations, the capital cost of extensive transmission dominates in all cases. Wells at higher elevation require additional cost to pump water but avoid potential treatment costs for pesticide contaminants associated with previous pineapple cultivation. DBCP (1,2-Dibromo-3-chloropropane) and TCP (1,2,3-Trichloropropane) are currently detected in Haiku aquifer wells below approximately 1,500 foot elevation. The higher cost associated with developing wells at higher elevation is a trade-off to avoiding the costs and risks of contaminated aquifers at lower elevations.

Figure 15-31 Historic Agriculture in Haiku and Paia Aquifers



Source options and strategies for the MDWS Upcountry System were analyzed by MDWS engineering in the 2013 "Water Source Development Options Report for the South-Central Maui and the Upcountry Maui Areas". The Haiku aquifer is abundant in source capacity, the study recommended Haiku aquifer the prime candidate. [71] A scenario to develop 5.3 mgd between five wells in Haiku aquifer and one well in Makawao aquifer, and related transmission, tanks and booster pumps was assessed to $53.3M. The cost to upgrade existing booster pump stations and to replace the existing Kula transmission line and Omaopio Tank was assessed to $20.8M. Total cost of improvements of the Upcountry Water System would be $74.1M. 20-year projected life cycle cost was $4.50 per 1000 gallons.

The Haiku aquifer has been marginally developed and no extensive hydrologic study undertaken. Whether perched water, a higher level groundwater storage above the basal lens, is what feeds the streams must be evaluated by a hydrologic study and monitoring wells. In the 2016 public review of preliminary strategies, the need for hydrologic studies of the Haiku aquifer was emphasized. Compliance with the terms of the East Maui Water Development Plan Consent Decree is necessary.

Strategy #5 in the Wailuku ASEA Report to continue exploration of East Maui well development for the MDWS Central System can theoretically serve a dual purpose to include source for the MDWS Upcountry System. Interconnection could provide a limited amount of redundancy of production equipment. However, this is of limited value since the Upcountry System is limited by source water capacity in drought rather than redundancy. New resources are necessary to meet demand. The 1995 Paia-Haiku Community Plan's objective "Ensure adequate supply of groundwater to residents of the region before water is transported to other regions of the island" is not assumed to preclude groundwater development that benefit the Upcountry System as a whole.

Strategy #4: Explore East Maui well development in combination with Makawao aquifer basal groundwater to meet projected demand on the MDWS Upcountry System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes. Potential yield is more than the needed 6.3 mgd (potentially in addition to development for the MDWS Central System). Lead agencies would be CWRM and MDWS and hydrologic study to be completed by USGS.

<u>Paia Aquifer</u>

The Paia aquifer was not considered as a preliminary strategy for potable source in the public process for the WUDP update. Most of the aquifer underlies agricultural land previously in sugarcane or pineapple cultivation. The Maunaolu well, serving a public water system, and the

[71] MDWS, Water Source Development Options Report for the Central-South Maui and the Upcountry Maui Areas, 2013

Hamakuapoko wells, serving the MDWS Upcountry System, require additional Granular Activated Carbon (GAC) treatment to remove chemical contaminants detected in the aquifer. Such additional treatment may be warranted where infrastructure is limited to serve individual projects. The Old Maui High School Campus Revitalization Project is not within the MDWS Central System or Upcountry System service areas. Well development with anticipated GAC treatment is a costly but a potential source option.

The 825 unit planned Haliimaile Development could also be served by existing wells or new well development in the Pā`ia aquifer. However, nitrate treatment may be necessary in addition to GAC considering high nitrate levels in nearby wells. It is not recommended that potable source with multiple treatment requirements is pursued if the project can be served by alternative sources outside the Paia aquifer. It is assumed that the Haliimaile Development is included in population growth based projections for the region.

The Hamakuapoko wells can only be used with certain caveats defined in Maui County Code 14.01.050. Water can be used as a backup to the MDWS Upcountry System, when a water shortage is declared, or for agricultural purposes. Although the source capacity of the wells is 1.5 mgd, it is assumed to be used 50% of the time in the future, providing 0.75 mgd supply to the MDWS Upcountry System.

Strategy #5: Explore Paia aquifer for non-potable demand, and potable use with additional treatment as necessary to serve projects included in the Maui Island Plan that cannot feasibly be serviced by MDWS source and infrastructure. Estimated demand for the Maui High School Campus is about 0.75 mgd. Lead agency is Maui County.

Kama`ole Aquifer Well Development

Kama`ole aquifer is geographically divided with the communities of Keokea and Ulupalakua roughly above 2,000 foot elevation and the Kihei to Makena communities roughly below 500 foot elevation. Water is brackish to semi-brackish in the coastal area and can continue to provide non-potable supply to meet irrigation demand in Kihei, Wailea and Makena areas.

Water quality and yield are uncertain at higher elevations. As stated in Chapter 15.6.3, DHHL's Kēōkea/Waiohuli project has planned potable water needs of about 0.809 mgd within the State Water Projects Plan time frame. A 1997 agreement for 0.5 mgd potable water from the MDWS Upcountry System is not sufficient to meet projected demand. An exploratory well at the 1,900 foot elevation is developed in the Kama`ole aquifer that is a feasible option. The WUDP does not adjust DHHL's planned strategy for potable source from the exploratory well and remaining credit from the MDWS Upcountry System. It is assumed that about 0.3 mgd will be needed from Kama`ole aquifer.

Groundwater Development to Meet Irrigation Needs

Issue and Background: Most of groundwater withdrawn for irrigation purposes are from Kama`ole aquifer. Future demand for golf course, resort and landscaping irrigation are projected to increase from 3.68 mgd to 5.59 mgd over the planning period. About 0.7 mgd of R-1 water can be used from the Kihei Wastewater Reclamation Facility. Remaining demand is assumed to come primarily from Kama`ole aquifer, and from Kahului and Paia aquifer existing wells.

The only reported irrigation use in Makawao aquifer is the Pukalani golf course, which also uses reclaimed wastewater. No expanded use is proposed. Non potable use of the Opana/Awalau tunnel and spring serve primarily agricultural uses Upcountry and possibly a limited number of irrigation needs. Any expanded use of this source is discussed under source development for agricultural demand below.

Strategy #6 in the Wailuku ASEA Report, Chapter 14.8.3 relates to irrigation demand in the Central ASEA: Basal groundwater imported from Wailuku ASEA to serve the MDWS Central System throughout Kahului and South Maui is generally of excellent quality, which should be prioritized for potable uses. Using brackish, semi-brackish and otherwise compromised quality water for non-potable uses can be achieved through dual distribution systems and increased use of alternative resources for non-potable demand. Strategy #6 calls for reducing non-potable uses of Wailuku basal water by prioritizing available R-1 water from the Kihei Wastewater Reclamation Facility and brackish groundwater from Kama`ole and Kahului aquifers. The strategy can be implemented through land use permit approvals, expansion of the recycled water distribution system and requirements, and improved water use data for Kamaole and Kahului aquifers.

Groundwater Development to Meet DHHL Non-Potable Needs

As stated in Chapter 15.6.3, DHHL's Kēōkea/Waiohuli project has planned non-potable water needs of about 0.578 mgd within the State Water Projects Plan time frame. Non-potable water is proposed to be supplied by the Upcountry Maui Irrigation System, which would be untreated surface water from the existing Kahakapao Reservoir. The DHHL recommends a coordinated effort be undertaken between DHHL, DOA and MDWS to determine the feasibility of utilizing the Upcountry Maui Irrigation System to supply the non-potable demands and, if so, to ensure that costs of the Kēōkea lateral are reflected in the AWUDP. All surface water currently diverted to the Kahakapao reservoir is used by the potable MDWS Upper Kula system. Because the project sponsors determine to discontinue construction and funding of the project, on site Kama`ole groundwater may be necessary.

Groundwater Development to Meet Agricultural Needs

Issue and Background: Agricultural irrigation has historically relied on affordable untreated surface water and plantation distribution systems. Affordable and reliable water supply to support agriculture is consistent with general plan policies and community plan objectives. Based on public input, agricultural water use needs to be more efficient and should increasingly

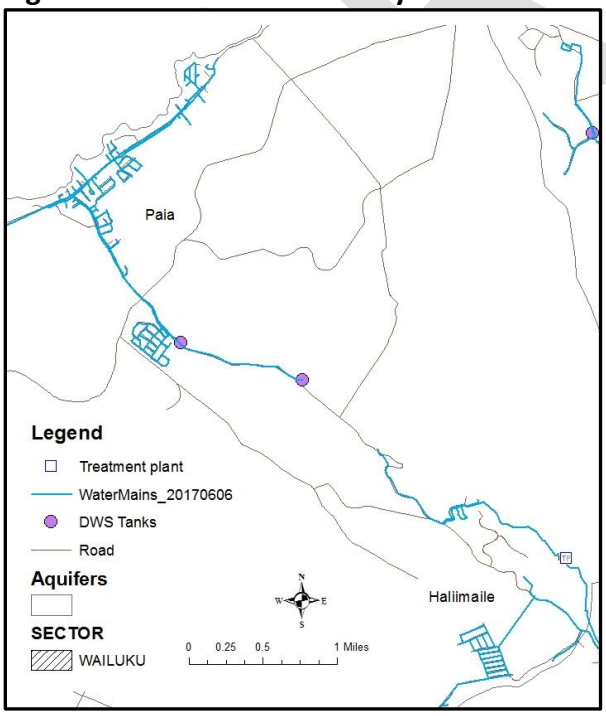
consider ambient rainfall and climate appropriate crops. A diversified supply is needed that combines sufficient reservoir storage to take advantage of high stream flows in wet season and to capture stormwater and regional rainfall, with non-potable groundwater as contingency in long-term drought periods. It is cost prohibitive to develop municipal potable groundwater and infrastructure capacity as contingency for agricultural zoned land. Expansion of cultivated agricultural land cannot be serviced by municipal potable supply but should identify alternative contingency sources.

The transition from sugarcane cultivation to diversified agriculture on the central isthmus has unknown impacts on groundwater availability in Kahului and Paia aquifers. In consistency with CWRM's June 2018 decision of the East Maui Streams Contested Case, it is assumed that brackish water from existing HC&S wells and shafts will be needed for up to 17.84 mgd. No new basal groundwater development is proposed. As recommended in the WUDP Chapter 12.3, the pending update of the Agricultural Water Use & Development Plan should address and coordinate with industry stakeholders alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water.

Groundwater Reliability and Efficiency: Interconnection of the MDWS Central System and Upcountry System

The MDWS Central System and the Upcountry System are not connected and are served by separate sources. The Central System ends above Skill Village in Paia and the Upcountry System terminates approximately 2,000 feet further mauka on Baldwin Avenue.

Figure 15-32 MDWS Central System Paia Terminus and Upcountry System Haliimaile Terminus



Interconnecting the two MDWS systems could provide improved reliability and operational economics. Costs and benefits were analyzed by Haiku Design and Analysis.[72]
The June 2018 Decision for East Maui Streams Contested Case does not preclude HC&S from diverting stormwater, available in periods of ample rainfall. Maximizing the use of surface water in wet season could provide economical water production for the Central System. This option would not displace the need to develop source for the MDWS Upcountry System. Using surface water generated in Ko`olau ASEA to support population growth in the Kahului-Wailuku or Kihei-Makena Community Plan areas appears to conflict with the following objective in the 1996 Makawao-Pukalani-Kula Community Plan: "Restrict the use of any water developed within or imported to the Upcountry region to consumption within the Upcountry region, with exception provided for agricultural use."

The source for the Central System is groundwater and the Upcountry source at the terminus is surface water from the Wailoa Ditch, treated at the Kamole water treatment facility. Introducing surface water to the distribution system in Paia have unknown impacts on water quality. Surface water can be more acidic and corrosive than groundwater which may cause leaching from lead plumbing in older homes. Strategy #7 in the Wailuku ASEA Report, Chapter 14.8.3 recommends monitoring of IIFS, available ditch flow and water quality implications of blending the water sources to determine the viability of interconnection.

Surface Water Use and Development

Surface water transport, use and allocation have been the focus for agriculture Upcountry and in Central Maui, and for growth in the Upcountry region. Objectives related to surface water use and development Upcountry include:

- Seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region.
- Support the development of separate domestic and irrigation water systems. Encourage the construction of additional storage capacity by the Department of Water Supply, commercial developers, and individual farmers to help alleviate the inadequate water supply.
- Encourage cooperative efforts among Federal, State, and County agencies, and developers to ensure that water storage and delivery needs of the region are met in a timely and orderly manner.
- Ensure that the development of new water sources does not adversely affect in-stream flows.
- Increase water storage capacity with a reserve for drought periods.

[72] Haiku Design & Analysis, Maui County Water Use and Development Plan Candidate Strategies Central District Preliminary Draft, September 12, 2006

Surface Water Allocation for Agricultural Needs

Issue and Background: The diverted streams in East Maui are not in a designated surface water management area. That means that CWRM does not allocate off-stream uses by water use permits. Water for off-stream uses is licensed by the Board of Land & Natural Resources (BLNR). The State Water Code states that each county shall adopt a WUDP that sets forth the allocation of water to land use. The State Water Code and the Maui County Code do not explicitly provide any authority to implement or enforce water allocations. The WUDP serves to both guide land use decisions and to implement the County General Plan. Water resources and infrastructure to meet future agricultural irrigation needs are also under the purview of the Agricultural Water Use and Development Plan, currently under update.

The history and background of the East Maui Streams Contested Case was addressed in the WUDP Introduction Chapter 5.3 and Ko`olau ASEA Report Chapter 16.2. Since the WUDP chapter for the Ko`olau ASEA was published for review, CWRM issued their decision in the Contested Case over East Maui Streams and established Interim Instream Flow Standards (IIFS). CWRM continues to allow some streams to be diverted, which includes freshets and stormwater. Stream flow under various conditions that would be available to divert after meeting established IIFS based on the June 20, 2018 Findings of Fact, Conclusions of Law and Decision and Order (FoF, CoL and D&O) were assessed in Chapter 15.7.4. Not all of projected irrigation water needs under A&B Properties/HC&S's Diversified Agriculture Plan will be met based on median base flow from the streams that can continue to be diverted. It is expected that a sufficient amount of water would be available (after meeting IIFS) to provide the initial phase of diversified agriculture on designated Important Agricultural Lands.

Tentatively, about 28 mgd of base flow is estimated to be available from Wailoa Ditch under normal conditions. Uses include MDWS municipal needs, the Kula Agricultural Park and A&B/HC&S diversified agriculture. However, because freshets and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions. An agreement between A&B and MDWS is needed to allocate Wailoa Ditch water under the established IIFS. If the current terms continue, MDWS would receive 12 mgd from Wailoa Ditch with an option for an additional 4 mgd, for a total of 16 mgd. During periods of low flow, MDWS receives a minimum allotment of 8.2 mgd and HC&S receive 8.2 mgd. If less is available both receive prorated shares of the water available.

<u>Diversified Agriculture on HC&S Lands</u>

CWRM established that the HC&S lands that are completely dependent on surface water require 28.28 mgd. With water losses the gross need is 36.59 mgd. The table below estimates the amount available for HC&S to divert from the streams subject to the June 2018 Decision, amount available from streams not subject to the contested case, and brackish groundwater according to the June 2018 Decision.

Table 15-36 Available East Maui Streams and Brackish Groundwater Resources for HC&S

Available Baseflow to Divert at Wailoa Ditch Q50 (Q90)	Streams West of Honopou to Maliko	Brackish (pro-rated based on total irrigation	Total Available Median Flow
20.35 (2.21)	8.00	17.84	46.19

In the June 2018 Decision, CWRM's best estimate is that IIFS provides for about 90 percent of the irrigation needs for lands designated Important Agricultural Lands.[73] Because ditch flow for offstream uses is not addressed in the decision, it is difficult to identify available flow from Wailoa Ditch as a whole. According to provided stream data and established IIFS, our calculations show that there would not be sufficient base flow under normal or drought conditions to meet HC&S's proposed needs. The total flow is unknown, but for planning purposes assumed to be **35 mgd** until informed through water use reporting under the new IIFS. HC&S has not considered building additional or larger reservoirs. HC&S contracted a feasibility study for utilizing recycled wastewater from the Kahului Wastewater Reclamation Facility for use on fields served by Na Wai Eha surface water. The study did not assess the cost of conveying recycled water to the fields served by East Maui surface water. Although alternative resources to potentially meet the proposed irrigation demand for the Diversified Agriculture Plan can be developed, HC&S deem alternatives cost prohibitive for viable agricultural pursuits. Alternative resources should be further explored as new crops are established and needs change over the WUDP planning period. Recycled water from the Kahului Wastewater Facility, and stormwater reclamation should be further scrutinized as viable options for agricultural irrigation in the update of the Agricultural Water Use & Development Plan and in land use permitting. This strategy (Strategy #4 in the Ko`olau ASEA Report, Chapter 16.8.3) applies both to Ko`olau and Central hydrologic units:

Strategy #6: Consider alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water in land use permitting to mitigate low flow stream conditions. Require alternative sources for irrigation when reasonably available in county discretionary land use permitting.

Kula Agricultural Park

Non-potable water for Kula Agricultural Park is pumped from HC&S reservoirs to the Park via the Upcountry Maui Irrigation System. Surface water from Wailoa Ditch bypasses the Kamole Water Treatment Facility. An expansion of 373 acres is in progress, with 71 acres currently being farmed. There is 0.6 mgd from A&B Reservoir 40 available for the additional 302 unused acres under a 2002 agreement. Additional storage capacity and a long term source agreement

[73] CCH-MA13-01 June 18, 2018 Findings of Fact, Conclusions of Law, & Decision and Order

are needed. Water delivery infrastructure funding will be sought from state and federal sources.[74]

Diversified Agriculture Upcountry

Farming Upcountry outside the Kula Agriculture Park generally uses municipal potable water supply for all irrigation needs. The Upcountry Maui Watershed Plan, initiated in 1997, proposed to install a separate agricultural water distribution system to supply untreated water for irrigation purposes to farmers in the Upper Kula area. The proposed water source, Kahakapao Reservoir, is the same storage system of Ko`olau diverted stream water that currently supplies the MDWS Upper Kula potable system. The surface water diverted at Waikamoi 4,000 feet elevation is available to service potable needs via gravity flow. The source is extremely valuable as the alternative, pumping ground or surface water uphill to serve existing needs is generally cost prohibitive but nevertheless subsidized both in terms of general and agricultural water rates. In October 2017, the project sponsors determined to discontinue the project, based on economics, project timeline and federal requirements. [75]

The Opana and Awalau surface water source located in the Ko`olau ASEA was described in the Ko`olau ASEA Report Chapter 16.5. An analysis by Haiku Design & Analysis assessed the feasibility of expanding reservoir capacity and thereby the yield of the Opana/Awalau system for non-potable uses. A mass flow analysis determined the reliable yield of this source assuming several possible reservoir capacities. Because there were extended periods the analysis was based on providing "semi-reliable" yield in which the reservoir would be empty 10 percent of the time. Based on this analysis, it is not practical to provide drought period service reliability by expanding reservoir capacity. The yield of approximately 0.14 mgd is used by a partnership of agricultural users, including MDWS non-potable customers. It is recommended to continue and maintain this source as a non-potable water source.

Input from farmers in the region indicate that treated potable water is necessary to some extent due to Food and Drug Administration standards for produce. Potable water through the municipal system will still be needed.

In summary, agricultural irrigation needs Upcountry depend on reliable source that includes potable and non-potable water. A long term agreement that reflects the established IIFS and alternative ditch flows for the EMI system is required.

Strategy #7: Execute a long term source agreement for use and maintenance of the Wailoa Ditch that ensures adequate non-potable supply for the Kula Agricultural Park expansion and potable supply for projected MDWS Upcountry System needs over the planning period. Lead agencies are Maui County, MDWS and A&B Properties.

[74] Maui County Office of Economic Development presentation, Maui County Council Budget and Finance Committee, November 3, 2015.
[75] 10/4/17 USDA Soil & Water Conservation District letter

Surface Water Allocation for Municipal Needs

Issue and Background: Water provided by the MDWS Upcountry System is for municipal purposes. Current reliance on surface water for over 80 percent of freshwater supplies puts the Upcountry System at risk in extended droughts. Decreasing rainfall, whether as a result of long term droughts or climate change, has more immediate impacts on surface water flows making surface water vulnerable and generally less reliable over short terms than groundwater. Groundwater is generally preferable to meet long-term reliable supply. Haiku aquifer has sufficient yield to supply projected growth Upcountry. However, well development in the Haiku aquifer must comply with the East Maui Consent Decree. The MDWS's efforts to initiate hydrologic studies and explore regional groundwater have been challenged. It is not certain that basal groundwater development in Haiku aquifer will be achievable. Makawao aquifer yield cannot support the full projected need.

New source of about 6.3 mgd is needed to meet municipal needs and the Upcountry Meter Priority List. As stated earlier, the preferred option is to operate ground and surface water resources in the most economical manner during normal conditions with sufficient groundwater contingency source to supplement available surface water during droughts. This strategy is consistent with measures recommended for Upcountry by the Maui Drought Committee.[76]

MDWS relies on three surface water sources, one of which is delivered by EMI through the Wailoa Ditch, and the other two through two MDWS higher elevation aqueducts maintained by EMI that transport water to Olinda and Kula, under a contractual agreement originated under the 1973 East Maui Water Agreement and subsequent agreements.

Table 15-37 MDWS Upcountry System Surface Water Treatment Capacity

Water Treatment Facility	Elevation	Conveyance System	Production Capacity	Average Production
Olinda	4,200 feet	Upper Kula Flume	2.0 mgd	1.6 mgd
Piiholo	2,900 feet	Lower Kula Flume	5.0 mgd	2.5 mgd
Kamole-Weir	1,120 feet	Wailoa Ditch	6.0 mgd	3.6 mgd

Recent amendments to the Interim Instream Flow Standards (IIFS) on East Maui streams results in decreased base flows in the Wailoa Ditch. Depending on future extent of droughts, the pace of increasing irrigation demand on the plantation and the utilization of brackish groundwater and other alternative sources, low flow conditions may not satisfy IIFS nor off stream needs for periods of time that is difficult to predict. In drought conditions, both the Lower and Upper Kula systems require supplemental surface water from Kamole Weir and groundwater pumped up to 4,000 feet. Under current agreement with EMI, MDWS receives 12 mgd from the Wailoa Ditch with an option for an additional 4 mgd. During periods of low flow, MDWS will receive a minimum

[76] Wilson Okamoto Corporation, County of Maui Drought Mitigation Strategies, 2012 Update

allotment of 8.2 mgd with HC&S also receiving 8.2 mgd, or prorated shares if less water is available. The August 2017 Proposed Decision restricted Wailoa ditch flow for off stream uses so that less than 7 mgd would be available a few days a year. When more than 7 mgd is available under non-drought conditions, the proposed restored amount would come from EMI's share of the 16.4 mgd. Under normal flow, exceeding 16 mgd at Wailoa Ditch, and under an allocation of up to 12 mgd for MDWS, ditch flow could theoretically meet additional needed source of 6.3 mgd.

Water Treatment Facility Expansion

Stream flow in Ko`olau ASEA and the IIFS proposed by the Contested Case Hearing Officer in August 2017 were analyzed in the Ko`olau ASEA Report. The 2017 proposal allowed current diversions for potable municipal needs to continue serving the Upcountry system.[77] The June 2018 Decision allows continued diversions for the Upper Kula and Lower Kula subsystems. It is assumed that current production can continue at the Olinda WTF and the Piiholo WTF.

The Kamole WTF, located at 1,120 feet elevation, utilizes the treatment processes of coagulation, flocculation, filtration, disinfection and pH adjustment for corrosion control. The majority of the treated water is boosted by the high service pump station to higher service elevations. The highest monthly average production over a ten year period is about 5.5 mgd.

Tentatively, about 28 mgd of base flow is estimated to be available from Wailoa Ditch under normal conditions. Because freshets and stormwater are allowed to be diverted, much more would potentially be available to divert during "normal", or wet season conditions. An assessment of Wailoa Ditch flow is needed to evaluate whether MDWS municipal needs, the Kula Agricultural Park and A&B/HC&S diversified agriculture plans can be met subject to recently adopted IIFS.

An agreement between A&B and MDWS is needed to allocate Wailoa Ditch water under the established IIFS. EMI provides water to MDWS under a Memorandum of Understanding (MOU). If the current terms continue, MDWS would receive 12 mgd from Wailoa Ditch with an option for an additional 4 mgd, for a total of 16 mgd. During periods of low flow, MDWS receives a minimum allotment of 8.2 mgd and HC&S receive 8.2 mgd. If less is available both receive prorated shares of the water available. Treatment of up to 12 mgd at 1,100 foot elevation would be a more cost effective resource to operate long term compared to pumping groundwater from near sea level to 1,100 feet. Life cycle costs over 20 years for surface water treatment at Kamole Weir was estimated to $3.50 per 1,000 gallons in 2013. Groundwater pumpage increases life cycle costs by $1.64 to $5.93 per 1,000 gallons. Water from Kamole Weir can be booster pumped to supplement the Lower Kula and Upper Kula systems as needed.

Treatment of more than 6 mgd at the Kamole Weir will require expansion of the water treatment facility (WTF) and storage construction. Treatment plant expansion is conditioned upon an

[77] CCH-MA-13-01 Hearing Officer's Proposed Findings of Fact and Conclusions of Law, August 2017

agreement with A&B Properties to secure long term ditch flow allocation under alternative flow conditions. Treatment expansion is also contingent on reservoir storage.

Raw Water Storage Development

Raw water storage does not provide new source per se, but reduce the effects of low ditch flows by allowing surplus water to be stored during periods of high flows in the ditch to be used over periods where there is not sufficient flow for direct distribution. Raw water storage to supplement the reliable yields of the existing MDWS Upcountry surface water treatment systems was analyzed in the 2009 WUDP Upcountry District Final Candidate Strategies Draft Report by Haiku Design & Analysis. Additional reservoir storage capacity increases the drought period reliable yield. Large new storage reservoirs require substantial up-front capital investments that yield long term benefits in reduced system operation costs. The optimal capacity of raw water storage is a function of the amount of water and the streamflow characteristics of the stream, the capacities of the stream diversions and transmission. Haiku Design & Analysis performed a detailed reservoir reliability and economic analysis for the Upper Kula, the Lower Kula and the Makawao subsystems. A mass flow analysis of historic streamflows, anticipated reductions in stream base flows and collection system and treatment plant characteristics determined contribution to system service reliability during drought and normal conditions for various assumed reservoir capacities for each Upcountry subsystem. Costs for estimated for various reservoir options and the analysis was conducted in several iterative rounds, considering integrated operation of the subsystems and other factors. Raw water storage compared to other resource strategies, such as basal well development, is more expensive if considered over a 25-year planning period. Considered over a 50 year study period, raw water storage is more cost effective. [78]

Raw Water Storage for Piiholo Water Treatment Facility

The Lower Kula subsystem served by the Piiholo WTF is the most economical location for additional storage expansion. A major constraint the location is the environmentally sensitive area, which also limits the size of a reservoir. Although cost effective in terms of reduced electrical power consumption and operating costs, construction of a 100 – 300 MG reservoir near or east of Piiholo WTF is not deemed practical. [79]

Raw Water Storage for Kamole Water Treatment Facility

New raw water storage at the Kamole WTF was evaluated in a 2015 Preliminary Engineering Report (PER) to reduce the effects of low flows in the Wailoa Ditch. The PER is based on the

[78] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report, July 27, 2009
[79] Ibid.

assumption that up to 8 mgd per 24-hour period will be made available to MDWS, continent upon available flow in the Wailoa Ditch. The analysis determined required storage for a sustainable flow rate of 5 mgd and 8 mgd. [80] The majority of water treated at the Kamole WTF is boosted to service areas at higher elevations. There is currently no storage of raw water at the WTF. The 2015 PER recommended initial construction of a 48 MG reservoir at a cost of $8.7 million, with an additional four reservoirs totaling 441 MG at a cost of about $50M.

Table 15-38 Required Reservoir Storage for Year-Round Sustainable Supplies of 5 and 8 MGD

Scenario of Take from Wailoa Ditch	5 MGD Supply (MG)	8 MGD Supply (MG)
Unrestricted	47	92
Only Flows Above 10 MGD	138	279
Only Flows Above 20 MGD	279	470
Only Flows Above 30 MGD	336	569

Source: Storage Yield Analysis by Tom Nance Water Resource Engineering, July 15, 2014

The analysis by Haiku Design & Analysis showed that this option would cost less than addition of basal wells in Haiku aquifer. Service life can be assumed to be much longer and operational costs comparatively low. The optimal size for new capacity at the Kamole WTF was determined at 100 – 200 million gallons (MG). A 20 mgd reduction in Wailoa Ditch base flow would require 100 MG. A 30 MGD reduction in base flow would require a 200 MG reservoir.[81] Ditch flows based on the June 2018 Decision have yet to be assessed. Financing of raw water storage reservoirs may not be available as State Revolving Fund loans and needs to be identified.

In summary, reservoir and treatment plant expansion would have multiple benefits:

1. Improve reliable capacity
2. Economical water supply that minimized expensive groundwater pumping costs
3. Defer source development in Haiku aquifer in light of uncertainties related to the East Maui Consent Decree
4. Recharge regional groundwater in wet season when maximizing use of stormflow from rainfall

If financing can be secured, raw water storage construction presents an economic strategy compared to basal well development. If a string of basal wells and extensive transmission would be added to the MDWS Upcountry System during the same time frame as a reservoir, the economic benefit would be significantly diminished. Both resource strategies have long implementation time frames and can be adjusted over time. Should development of basal source in the Makawao aquifer produce adequate yield and quality, additional wells in Haiku

[80] Austin, Tsutsumi & Associates, Inc. Preliminary Engineering Report for Kamole Water Treatment Plant Raw Water Reservoir Draft. May 11, 2015

[81] Haiku Design & Analysis, Maui County Water Use and Development Plan Upcountry District Final Candidate Strategies Report, July 27, 2009

aquifer ***OR*** expanded surface water storage and treatment will meet projected demand. Uncertainties in future stream flow must be weighed against increased reliability and cost of basal well development. Maximizing affordable surface water use in wet season must be weighed against "over building" expensive wells and infrastructure that is not used to capacity.

Strategy #8: Pursue hydrologic studies needed to explore the Haiku aquifer **and** an updated ditch flow analysis to optimize raw water storage and treatment plant capacity at Kamole Weir in order to expedite the most feasible new source. Raw water storage and Kamole Water Treatment Facility expansion are contingent on a long term agreement with A&B Properties allocating adequate surface water for the MDWS Upcountry System. Lead agency is MDWS.

This strategy supports multiple planning objectives, including to seek expanded municipal withdrawal from the lowest cost source to serve the Upcountry region and to increase water storage capacity with a reserve for drought periods.

It should be noted that improved storage and transmission efficiencies and limited source development have resulted in meters currently being offered to applicants on the Upcountry Meter Priority List. Although the creation of the List was due to source shortage, the pace of meter offerings is slow due to the backlog of applications, staff resources, and the complexity of processing meter offers.

15.8.4 Climate Adaptation

Issue and Background: Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall, declining stream base flows, decreasing groundwater recharge and storage, and increased coastal groundwater salinity, among other impacts associated with drought. Reliance on surface water will become more uncertain in a future of longer droughts and varying rainfall. No streamflow projections are available for the coming century but projections include a decline in base flow and low flows, with stream flows becoming more variable and unstable (flashy), especially in wet years. [82] Groundwater recharge decreases in drought but local impact from climate change has not been projected to date.

The Central ASEA is especially vulnerable due to water resources used:

- Upcountry region and agriculture dependent on surface water as primary resource.
- Irrigation and other non-potable wells in Paia and Kamaole aquifer coastal areas are subject to sea-level rise

In consistency with the *Climate Change Adaptation Priority Guidelines*, water purveyors should increase resilience and reduce vulnerability to risks related to climate change. Chapter 12

[82] Summarized from EcoAdapt. 2016. Climate Changes and Trends for Maui, Lāna'i, and Kaho'olawe. Prepared for the Hawaiian Islands Climate Synthesis Project

Island Wide Strategies in this plan include the following strategies that can mitigate impacts from climate change:

1. Continue Maui County financial support for watershed management partnerships' fencing and weed eradication efforts (Chapter 12.3, Strategy#1). The Central ASEA is heavily dependent on forested watersheds in the Wailuku and Ko`olau hydrologic units to provide fresh water supplies.
2. Demand side conservation measures, such as water conserving design and landscaping in new development, incentives for efficient irrigation systems, landscape ordinance and promoting xeriscaping in dry areas will increase tolerance for prolonged droughts. (Chapter 12.3 Strategies # 13, 14, 15, 17)
3. Promote alternative resource incentives, such as greywater systems and rainwater catchment to supplement conventional resources. Incentives for green infrastructure and use of alternative water sources are needed to ensure such upfront investments in new development. (Chapter 12.3 Strategies# 20 and 21)
4. Diversify supply for agricultural use to increase reliability. Under extended droughts and low stream flows, diversified agriculture on HC&S lands will compete with priority public trust uses for surface water. Planned extension of R-2 recycled water from the Kahului WWTF to HC&S fields can supplement groundwater from the Central aquifer sector. (Chapter 12.3 Strategy #51).
5. Expand requirements for new development to connect to recycled water infrastructure, promote closer collaboration between MDWS and MDEM to utilize Drinking Water State Revolving Funds to maximize recycled water use. (Chapter 12.3 Strategies # 61 and 62)
6. Explore and promote opportunities for large volume stormwater runoff for agricultural irrigation. (Chapter 12.3 Strategy # 66)

15.8.5 Alternative Water Source Strategies

Residents want to maximize use of alternative sources of water (R-1 wastewater, rainwater, greywater, etc.) which would mitigate well and surface water use and the transport of water. Planning objectives related to alternative water sources identified in the WUDP update public process and pertinent community plans include:

- Maximize efficiency of water use.
- Promote conservation of potable water through use of treated wastewater effluent for irrigation.
- Reuse treated effluent from the County's wastewater treatment system for irrigation and other suitable purposes in a manner that is environmentally sound.
- Explore the development of alternative water sources (e.g., grey water, catchment systems, etc.) to meet the needs of diversified agriculture, businesses and residents.

Qualitative criteria to evaluate and measure resource strategies against this planning objective include:

- Use of recycled water increased
- Graywater and catchment systems installed
- Infrastructure projects increase recycled water use and stormwater capture

Recycled Water

Issue and Background: Wastewater reclamation in Central Maui is managed by the Maui Department of Environmental Management (MDEM). Recycled water from the Kahului Wastewater Reclamation Facility (WWRF), the Kīhei WWRF and the private Mākena WWRF are all located in the Central ASEA. The Kihei WWRF supplements the MDWS Central System. Recycled water has the potential to offset demand in the Central ASEA that would otherwise be supplied by conventional water resources. Recycled water availability and uncertainties are analyzed in Chapter 11.2.

<u>Kahului Wastewater Reclamation Facility</u>

R-2 water from the Kahului WTF can offset limited demand on the MDWS Central System as the approved uses of R-2 water are restricted. Treatment upgrade to R-1 quality and expansion of distribution from the Kahului WWRF to the Maui Lani area, the Kahului airport and Kanaha Beach Park were estimated to about $35M and has great potential to offset potable water while reducing effluent discharge to injection wells. There are no current plans or budget allocated for these projects.

The fiscal year 2018 MDEM budget included a $6.7M project to design a new distribution line connecting the Kahului WWTF to an existing line at the old Maui Pineapple processing facility in Kahului. Recycled water would then be available for landscape or agricultural irrigation on HC&S lands east of Kuihelani Highway. The project could preserve brackish water resources and offset irrigation demand on portions of the 1,951 acres of HC&S lands currently slated for "Large Diversified Farm Leases".[83] The Central Maui recycled water distribution system has not been developed to date because the majority of candidate commercial properties currently utilize inexpensive brackish or ditch water.[84] Irrigation of an energy crop on HC&S land that is not subject to the stricter requirements for edible crops, would benefit MDEM by reducing its reliance on injection wells for effluent disposal, and would benefit the HC&S lessee by displacing irrigation water otherwise diverted from Na Wai Eha or East Maui streams. The project could serve to offset conventional resources from Ko`olau, Central and Wailuku aquifer sectors. This strategy applies to the Wailuku ASEA Chapter 14 as well.

Strategy #9: Expand distribution from the Kahului WWTF and the application for planned energy crops. Potential available recycled water is 4.2 mgd. Lead agency is MDEM.

Kihei Wastewater Reclamation Facility

The Kīhei WWRF serves the South Maui area from Wailea to Sugar Beach. As with potable water, recycled water production must meet their customers' needs at all times. As demand peaks during the summer months, MDEM estimates they have as little as 0.7 - 1 mgd of excess recycled water available during the peak demand months of summer. Therefore, peak use limits additional potable water displacement unless a seasonal storage reservoir or brackish groundwater can supplement peak demand use. MDEM projects currently budgeted (as of April 2018) include two projects:

1. Liloa Drive distribution line design, to create a looped system and reliable service to the planned Kihei High School. The $0.5M project will coincide with roadway construction.
2. Second storage tank and booster station to provide more reliable service for existing R-1 customers and allow for more customers to connect to the South Maui recycled system. The project is budget to $6.2M to be implemented in 2018.

These projects will increase reliability and offset potable water from the MDWS Central System and benefit the Wailuku ASEA and Central ASEA. Funding is a key constraint to implement planned expansions of the R-1 system.

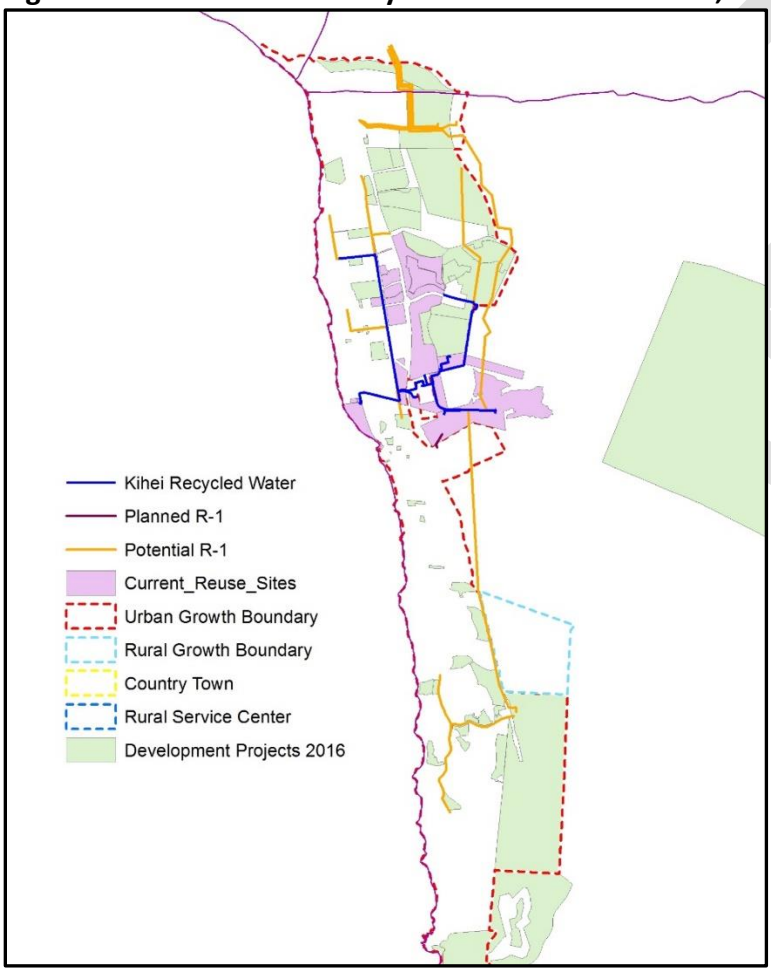
The 2009 Maui WUDP Central DWS District Plan update and the 2009 South Maui R-1 Recycled Water Verification Study explored a new transmission line to the Wailea area to displace potable water used for irrigation purposes. About 1.1 mgd of potable water could potentially be offset during the winter months when R-1 water use at existing and planned future

[83] Mayor's Proposed Budget FY2018 Capital Improvement Program CBS-1171
[84] 2010 Central Maui Recycled Water Verification Study

properties decreases. Capital costs for 26,235 feet of transmission, 19 service laterals, two R-1 storage tanks, and ultra violet disinfection, pressure reduction and pump station upgrades were estimated to $21M. The viability and potential funding of this strategy is still not determined. Strategy #8 applies to Central ASEA and Wailuku ASEA.

Strategy #10: MDWS and MDEM collaborate to identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kihei WWTF and supplemental non-potable sources for seasonal use of R-1 water. Lead agencies are MDEM and MDWS.

Figure 15-33 South Maui Recycled Water Service Area, Planned and Potential Expansion



It's preferable to provide the non-potable infrastructure in design and construction rather than retrofitting existing uses with separate non-potable distribution lines and backflow preventer to avoid cross-contamination.

Rainwater Catchment Systems

Issue and Background: Rainfall averages 15 inches along the southern coastline on Haleakala, and it increases to 70 inches as one moves eastward and into higher elevations.[85] Rainfall catchment systems occur in the eastern part of the hydrologic unit, from Makawao and Olinda and also scattered throughout Kula. Catchments systems using potable treatment technologies have been installed Upcountry due to water meter limitations imposed by the Upcountry Meter Priority List. Determining appropriate system sizing requires an accurate analysis of water demand relative to precipitation patterns.[86] The feasibility of using catchment for domestic use depends on demand, catchment area such as roof area, rainfall patterns and storage capacity. Scenarios illustrating average demand, catchment area, rainfall and required storage is provided in Chapter 11.2. Rainfall (low to high) presented is similar to averages for the Kahului, Pukalani and Haiku areas, respectively.

Rain barrels and cisterns for individual household use can supplement irrigation on a limited basis throughout the region, with less potential in dry South Maui. Catchment systems are not regulated by the county. However, rain barrel incentive programs are included in recommended demand side conservation strategies and the MDWS conservation program.

Catchment systems for agricultural uses have historically played an important role Upcountry. Support for increased adaptation to natural ambient rainfall and climate adapted crops is consistent with the objective to use appropriate water quality for appropriate uses. To reduce demand for off stream uses of surface water, rainwater catchment for diversified agriculture could potentially increase. Where ambient rainfall can adequately satisfy agricultural demand during normal rainfall conditions, conventional resource use including surface and ground water can be used solely as contingency.

Stormwater Reuse

Issue and Background: Stream flows becoming more variable and unstable (flashy) is predicted, especially in wet years. Stormwater capture and use can provide multiple mitigating effects on climate change, including off-setting potable supply for irrigation needs; recharging low level and more brackish portions of the region's aquifers; and mitigating sediment runoff reaching the nearshore marine environment and reefs. Stormwater management is under the Maui County Department of Public Works responsibilities. The East Maui Irrigation System and the surface water diversions serving the Lower Kula and Upper Kula regions capture stormwater as total flow. Increased transmission efficiencies, raw water storage and treatment plant expansion indirectly increases the use of stormwater from these systems.

[85] Johnson Engott, USGS, Spatially Distributed Groundwater Recharge Model, Maui 2014-5168, page 6.
[86] US EPA. *Rainwater Harvesting- Conservation, Credit, Codes, and Cost Literature Review and Case Studies*, January 2013, pp. 3-4.

Stormwater reclamation and reuse can also offset landscape irrigation demand at the project or household level. Strategy #22 in the WUDP Part II addresses incentives and code revisions to promote incorporating green infrastructure in new development.

Desalination

Issue and Background: Desalination is more costly than conventional water resources due to treatment and monitoring requirements, although costs have been decreasing. The energy intensive technology currently available would add freshwater supplies but not provide other environmental co-benefits. Supplying 10% of Maui's current municipal demand with brackish desalinated water would require an estimated 14% of MDWS current energy demand. The energy demand for the same amount of seawater desalination would be about 45% of current MDWS energy demand. [87]

Desalination of brackish water is generally more cost-effective and environmentally-friendly than use of sea water. Effects on Kahului and Paia aquifer chlorides due to reduced irrigation are issues, along with impacts on source water quality, and wastewater disposal injection wells. However, since brackish groundwater contributes toward the sustainable yield of the aquifer, desalination of sea water can be advantageous because it is not a limited resource.[88] Overall, desalination may have potential within the 20-year planning horizon but does not warrant a recommended strategy aside from continued monitoring of progress in technology and energy use.

A feasibility study that considered desalination of brackish groundwater or seawater determined that brackish groundwater was the more cost-effective option of the two.[89] A preliminary strategy for desalination of brackish groundwater includes the development of a 5.0 mgd reverse osmosis desalination facility in Central Maui to meet a portion of future needs on the MDWS Central System. Brackish groundwater would be pumped from the Kahului aquifer to supply the treatment plant. The reverse osmosis process would remove salt and other minerals to create potable water. Brine residual liquid stream created in the process would require disposal. Deep injection wells into salt water below the groundwater lens is considered to be the most practical and economical solution. [90]

Recommendations by the Board of Water Supply on the 2010 WUDP Central District stated that the Board sees desalination of brackish groundwater as one of the most expensive methods for supplying potable water and considered the byproducts of the process highly toxic.[91] Desalination is economically feasible but was not a favored strategy in the WUDP update public process. Uncertainty on imported energy sources, the high cost and environmental issues

[87] E.A. Grubert and M.E. Webber, Energy for water and water for energy on Maui Island, Hawaii, April 2015
[88] WRPP, 2008
[89] Brown & Caldwell, Central/South Maui Desalination Feasibility Study, Final Report, December 2006
[90] Ibid.
[91] Board of Water Supply April 30, 2010 letter to Maui County Council

associated with brine disposal are concerns. While the technology and energy source options are improving, sustainable brine management and disposal remains a challenge.

15.9 Recommendations

The Central Aquifer Sector is practically divided into the Upcountry Region and the communities in Central and South Maui even though some overlie the same hydrologic unit. Population growth and agriculture in the ASEA is highly dependent on imported water resources from the adjacent Ko`olau and Wailuku sectors. To mitigate water transport, a combination of aggressive conservation, investment in recycled water, increased reliance on ambient rainfall and climate adapted crops are needed.

Resource protection and augmentation strategies that benefit end uses in the Central ASEA are addressed in the Sector Reports where the generating watersheds and water resources are located. Protection and restoration of the East Maui watershed, the Mauna Kahalawai and the leeward Haleakala region are addressed in the Ko`olau, Wailuku and Kahikinui Aquifer Sector Reports.

Policies that drive water resource use and capital investments have been discussed by policy bodies, including the County Council and the Board of Water Supply but have yet to be resolved. Many of these policies are framed and recommended in this plan and sector report and other remain to be addressed. Identifying and allocating water resources to satisfy the Upcountry Meter Priority List and agricultural needs in the region are possibly the greatest challenges of this WUDP Update. The just recent adoption of Interim Instream Flow Standards for some East Maui Streams does not allocate water for offstream uses in the Central ASEA. Adoption of this plan would implicitly or explicitly make several policy determinations, such as:

1. Substantial capital investments and associated increased water system development fees are needed to develop new source and reliable supply for the Upcountry region, including the Upcountry Meter Priority List.
2. Investments in alternative water sources are required to meet projected agricultural irrigation demand.
3. Conservation programs that combine mandatory upfront investment and incentives are needed to aggressively cutback outdoor water use.
4. Less cost effective alternative resources, such as recycled water, are needed to mitigate water transports and to diversify water supplies in light of climate change.

The recommended strategies attempt to address the planning objectives derived from the public process, the Maui Island Plan, the pertinent community plans and the Upcountry District Water Advisory Committee. In summary, groundwater imports from Wailuku ASEA and Ko`olau ASEA are needed to supply projected population growth served by the Maui Department of Water Supply Central System and Upcountry System over the planning period. Exploration of East Maui basal water requires a comprehensive hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes.

Potable and non-potable supply to meet the selected demand scenarios are summarized in the table below. Demand and supply within the Central aquifer sector are included in the table, excluding the MDWS Central System which is addressed in Table 14-38 of the Wailuku ASEA

Report. As discussed throughout this chapter, the Wailuku, Central and Ko`olau hydrologic units are historically and currently closely entwined through water imports and exports. Resource use and projected demand for the MDWS Upcountry System as a whole is used for practical planning purposes, in addition to agricultural and other non-potable needs. Resources within the Central ASEA allocated to demand in the Wailuku ASEA are noted in the table.

The complexities in selecting the most appropriate source to meet demand and mitigate Upcountry drought conditions are significant. Development of groundwater in Ko`olau ASEA is subject to hydrologic studies and the East Maui Consent Decree. New wells carry relatively lower capital costs than new raw water storage but entail the uncertainty of the quantity and quality of water. Expansion of surface water treatment capacity and raw water reservoir construction are subject to ditch flow analysis based on the June 2018 established Interim Instream Flow Standards and a long term agreement of ditch water for municipal use. Actual projected potable demand is contingent on the portion of Upcountry Meter Priority List applicants accepting meter offers. Therefore, potable demand and source development needs by 2030 will certainly be adjusted. The selected source would be surface water use expansion, Haiku groundwater development OR a combination of the two. Surface water expansion of 4 mgd for a total of 11.7 mgd supply in 2030 is replaceable with 4 mgd groundwater development in Haiku aquifer. If surface water expansion is the preferred source strategy, as indicated in the table, there would be a surplus demand of about 3 mgd. The surplus would accommodate seasonal use, taking full advantage of affordable gravity fed surface water in wet season, with contingent basal groundwater use in dry season.

Non-potable agricultural demand will likewise certainly be adjusted as the HC&S plantation transitions to diversified agriculture. Unmet non-potable demand of 49 mgd is roughly estimated, based on proposed irrigation needs and unknown quantity of total flow. Increased efficiencies of the EMI system, climate adapted crops and irrigation best practices are anticipated to mitigate the non-potable supply shortage over the 20-year planning period.

Table 15-39 Selected Scenario Projected Water Demand and Supply Options Central ASEA and MDWS Upcountry System

DEMAND (MGD)	2014	2015	2020	2025	2030	2035
MDWS Potable (Upcountry excl. Priority List)	7.610	7.693	8.155	8.292	8.432	8.530
Upcountry Meter Priority List	7.3	7.3	7.3	7.3	7.3	7.3
Municipal Private Potable	0.235	0.239	0.268	0.295	0.327	0.356
DHHL Potable Kahului Aquifer	0.000	0.000	1.734	1.734	1.734	1.734
DHHL Potable Kamaole Aquifer	0.000	0.000	0.349	0.349	0.810	0.813
TOTAL POTABLE DEMAND	**15.145**	**15.232**	**17.806**	**17.970**	**18.603**	**18.734**
Irrigation Non Potable	3.683	3.744	4.201	4.627	5.133	5.591
Agriculture, Non Potable	191.452	191.452	35.415	35.415	58.220	101.030
Industrial, Non Potable	0.208	0.211	0.237	0.261	0.290	0.316
DHHL, Non Potable	0.000	0.000	2.434	2.434	2.434	2.434
TOTAL NON-POTABLE DEMAND	**195.343**	**195.408**	**42.288**	**42.738**	**66.078**	**109.372**
TOTAL DEMAND	**210.487**	**210.640**	**60.094**	**60.708**	**84.681**	**128.105**
SUPPLY (MGD)						
Potable Groundwater Kahului Aquifer (serving MDWS Central System)*	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*	*1.093*
Potable Groundwater Kahului Aquifer (non MDWS)**	0.161	0.161	1.895	1.895	1.895	1.895
Potable Groundwater Kamaole Aquifer	0.027	0.027	0.027	1.036	1.497	1.500
Potable Groundwater Paia Aquifer***	0.248	0.998	0.998	0.998	1.500	1.500
Potable Groundwater Makawao Aquifer	0.139	0.500	0.500	1.300	2.000	3.000
Potable Groundwater Ko`olau ASEA Haiku Aquifer	0.81	0.81	1.4	1.4	1.4	1.4
Potable Surface Water Ko`olau ASEA	6.460	7.700	7.700	7.700	11.700	11.700
Conservation (8% per capita)	0.000	0.000	0.519	1.195	1.989	2.676
TOTAL POTABLE SUPPLY	**7.845**	**10.196**	**13.039**	**13.629**	**20.086**	**21.776**
Unmet Potable Demand	-7.300	-5.036	-4.767	-4.341	1.483	3.043
Non Potable Groundwater Kahului Aquifer	28.906	28.906	2.169	2.169	10.776	10.776
Non Potable Groundwater Paia Aquifer	29.258	29.258	9.081	9.081	9.081	9.081
Non Potable Groundwater Kamaole Aquifer	2.826	2.888	3.345	3.991	4.277	4.735
Non Potable Groundwater Makawao Aquifer	0.220	0.220	0.220	0.220	0.220	0.220
Non potable Surface Water Ko`olau ASEA ****	134.133	134.133	27.473	27.277	35.000	35.000
Recycled Water (South Maui WWTF) Offset MDWS Central System*****	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*	*2.280*
Recycled Water Kahului WWTF)******	0.000	0.000	*3.000*	*3.000*	*3.000*	*3.000*
Recycled Water Upcountry	0.19	0.19	0.19	0.19	0.19	0.19
TOTAL NON-POTABLE SUPPLY	**195.343**	**195.404**	**42.288**	**42.738**	**59.354**	**59.812**
Unmet Non-Potable Demand	0.000	-0.003	0.000	0.000	-6.724	-49.560
TOTAL SUPPLY	**203.187**	**205.600**	**55.327**	**56.367**	**79.440**	**81.588**

*accounted for in Wailuku ASEA Supply

** May also supply Pulehunui Ind. Development +3.8 mgd, source adequacy TBD

***Includes Old Maui High School Project 0.75 mgd, source TBD

****28 mgd base flow, est. 35 mgd Total flow

*****accounted for in Wailuku ASEA Supply
******potential. alt source for Ag. Not counted as available supply

The table below summarizes recommended strategies and indicates the planning objectives that each strategy supports. Estimated costs are, unless indicated otherwise, life cycle costs for the twenty-year planning period per 1,000 gallons. Life cycle costs include capital, operational and maintenance costs and include inflationary effects. Costs to develop and implement sustainability projects are not quantified per volume water supply. Lead agencies, or organization to implement a strategy is proposed as a starting point. The timeframe for implementation is indicated as short term – less than 5 years, and long term 5 – 20 years. Many strategies are multi-year actions with implementation beginning within 5 years and continuing through the long term (indicated as 1, 2).

Table 15-40 Summary of Recommended Strategies Central ASEA

	STRATEGY	PLANNING OBJECTIVES	ESTIMATED COST	IMPLEMENTATION 1: Short-term 1 – 5 years 2: Long-term 5 – 20 years	
				AGENCY	TIME-FRAME
	RESOURCE MANAGEMENT				
1	Explore funding and conduct a cost benefit analysis of improvements to the EMI non potable conveyance system to mitigate losses and preserve existing reservoirs at risk of decommissioning. Priority components and associated costs TBD.	Maintain sustainable resources Protect water resources Protect and restore streams Maximize efficiency of water use	N/A	Maui County A&B Properties/EMI	1,2
	CONVENTIONAL WATER SOURCE STRATEGIES				
2	Assess alternative options to restructure and process the existing Upcountry Meter Priority List to improve processing rate and adequate source development.	Provide adequate volume of water supply Maximize reliability of water service	N/A	MDWS	1, 2
3	Explore new basal well development in the Makawao aquifer to accommodate growth Upcountry and add reliable new source. Potential yield is up to 3 mgd. .	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts	$4.5 – 6.0/1000 gallons	MDWS DLNR Public/private partnerships	1, 2
4	Explore East Maui well development in combination with Makawao aquifer basal groundwater to meet projected demand on the MDWS Upcountry System. Initiate a hydrologic study to determine any negative impact on existing ground and surface water sources, stream flow and influences from dikes. Potential yield is > 6 mgd	Provide adequate volume of water supply Maximize reliability of water service Minimize adverse environmental impacts	$3.71*/1000 gallons	CWRM USGS MDWS	1, 2
5	Explore Paia aquifer for non-potable demand, and potable use with additional treatment as necessary to serve projects included in the Maui Island Plan that cannot feasibly be serviced by MDWS source and infrastructure. Estimated demand for the Maui High School Campus is about 0.75 mgd.	Provide adequate volume of water supply Maximize reliability of water service	N/A	Maui County	1, 2
7	Execute a long term source agreement for use and maintenance	Provide adequate volume of water supply	N/A	Maui County MDWS	

	of the Wailoa Ditch that ensures adequate non-potable supply for the Kula Agricultural Park expansion and potable supply for projected MDWS Upcountry System needs over the planning period.	Maximize reliability of water service		A&B Properties	
8	Pursue hydrologic studies needed to explore the Haiku aquifer **and** an updated ditch flow analysis to optimize raw water storage and treatment plant capacity at Kamole Weir in order to expedite the most feasible new source. Surface water strategies are contingent on a long term agreement with A&B Properties allocating adequate surface water for the MDWS Upcountry System.	Minimize cost of water supply Provide adequate volume of water supply Maximize reliability of water service Maintain consistency with General and Community Plans	Surface water $5.15/1000 gal (20 yr) (construction cost $50M, Operational $1.47/1000 gal) Groundwater $3.71/1000 gal	MDWS	1 2
ALTERNATIVE WATER SOURCE STRATEGIES					
6	Consider alternative sources of irrigation water including wastewater reuse, recycled stormwater runoff, and brackish well water in land use permitting to mitigate low flow stream conditions. Require alternative sources for irrigation when reasonably available in county discretionary land use permitting	Maintain sustainable resources Protect and restore streams Minimize adverse environmental impacts Maximize efficiency of water use Maintain consistency with General and Community Plans	N/A	Maui County DEM HC&S	1 2
9	Expand distribution from the Kahului WWTF and the application for planned energy crops. Potential available recycled water is 4.2 mgd	Maximize efficiency of water use Maintain consistency with General and Community Plans	$6.7M	MDEM HC&S	1 2
10	MDWS and MDEM collaborate to identify private-public partnerships, state and federal funding sources to maximize utilization of recycled water produced at the Kihei WWTF and supplemental non-potable sources for seasonal use of R-1 water.	Maximize efficiency of water use Maintain consistency with General and Community Plans	(Transmission South Kihei to Wailea $21M)	MDEM MDWS	1 2

*20 year total cost includes upfront capital costs, operation and maintenance, repair and replacement and does not include inflation and other economic factors

Abbreviations:

CWRM	Commission on Water Resource Management
DHHL	State of Hawai'i Department of Hawaiian Home Lands
DLNR	State of Hawai'i Department of Land and Natural Resources
DOA	State of Hawai'i Department of Agriculture
DOH	State of Hawai'i Department of Health
HRWA	Hawai'i Rural Water Association
Maui County	Maui County Administration and Maui County Council
MDEM	Maui County Department of Environmental Management
MDP	Maui County Department of Planning
MDPW	Maui County Department of Public Works
MDWS	Maui County Department of Water Supply
SWCD	Soil and Water Conservation District
UH CTAHR	University of Hawaii College of Tropical Agriculture and Human Resources
USDA	U.S. Department of Agriculture
USGS	U.S. Department of the Interior, U.S. Geological Survey
WWC	Wailuku Water Company

15.9.1 Implementation Program

In consistency with the Maui Island Plan, strategies recommended and adopted in the WUDP does not legally bind the agencies and organizations to execute. The recommendations provide guidance for land use and infrastructure, including the county capital improvement programs (CIP), over the planning period.

Timing and prioritizing of conventional and alternative resource strategies are tied to actual population growth and economic factors that drive individual development projects. Prioritizing and timing of strategies will also depend on available manpower and expertise by agencies and organizations tasked to scope out and execute a strategy. Funding is of course the driving factor of implementation. Conventional source exploration and development for the Upcountry region lies primarily with Maui County Water Department. The Upcountry Meter Priority List is a deviation from “planned growth” as it’s not accounted for in population growth for the Upcountry region. The demand is far in excess of socio-economic forecast projections. The pace of processing the List is highly dependent on county staff resources and priorities rather than funding. Upcountry source development, including satisfying the List, was estimated to $100 million at the time the Maui Island Plan was adopted. Raw water storage versus basal well development will roughly require the same level of capital investment. Funding of system expansions to serve growth should primarily be borne by new development to ensure that costs are distributed equitably to uses befitting from the improvements. The Water System Development Fee is the current funding mechanism.

Major projected capital costs are not limited to source development but includes improvement, replacement and upgrade of waterlines; and construction and replacement of water tanks. The MDWS infrastructure and the agricultural infrastructure are to a large extent in fair to poor condition and require major repairs and replacements over the planning period.

Agricultural needs largely fall outside the Maui Island Plan focus and projections. The two major areas – HC&S plantation and expansion of the Kula Agricultural Park – are expected to be addressed in the Agricultural WUDP Update underway by the State Department of Agriculture.

The alternative resource strategies rely on funding by the county agencies, but will also require creative public-private partnerships. Resource protection, conservation and alternative resource strategies have state-wide support including the following:

- The Hawai'i Fresh Water Initiative, launched in 2013 by the Hawai'i Community Foundation to increase water security for the Hawaiian Islands. A state-wide goal of 100 mgd in additional fresh water focuses on three aggressive water strategy areas and individual targets for the public and private to achieve by 2030: 1) **Conservation**: Improve the efficiency of the total underground aquifer water use rate by 8% with a target of 40 mgd in increased water availability; 2) **Recharge**: Increase Hawai'i's ability to capture rainwater in key aquifer sector areas by improving stormwater capture and nearly doubling the size of our actively protected watershed areas with a target of 30 mgd in increased water availability; and 3) **Reuse**: More than double the amount of wastewater currently being reused in the Islands with a target of 30 mgd in increased water availability by 2030.

- The watershed initiative program by the State Department of Land and Natural Resources "The Rain Follows the Forest" seeks to double the acreage of protected watershed forests by 2021.

Over the planning period, implementation and performance of the recommended strategies can be assessed using qualitative criteria and quantitative targets formulated in the WUDP Part I, Table 3-3. Goals and performance measures on an island wide basis is provided in Appendix 15.

APPENDIX 15 A East Maui Streams Assessment
Based on June 20, 2018 Findings of Facts, Conclusion of Law, and Decision & Order

Unit	Unit Name	No. of Diversions	6/20/18 CWRM BFQ50 at IIFS (mgd)	6/20/18 CWRM Adopted IIFS (mgd)	6/20/18 Restoration Status CWRM	Available to divert at Q50	Available to divert at Q90	Lowest Median Flow (Natural Stream Flow,Q50)	Lowest Q90
6027	Maliko	10							
6028	Kuiaha	30							
6029	Kaupakulua	15							
6030	Manawaiiao	3							
6031	Uaoa	6							
6032	Kealii	4							
6033	Kakipi	21							
6034	Honopou	23			Full	0.00	0.00	1.29	0.39
6035	Hoolawa	37							
6036	Waipio	15							
6037	Hanehoi	12		0.00	Full	0.00	0.00		
	Puolua			0.00	Full	0.00	0.00		
6038	Hoalua	4							
6039	Hanawana	5							
6040	Kailua	6						5.04	1.29
6041	Naili'ilihaele	12						0.47	0.05
6042	Puehu	1							
6043	Oopuola	15						0.61	0.17
6044	Kaaiea	3						1.55	0.45
6045	Punaluu	1							
6046	Kolea	8							
6048	Puohokamoa	8	5.43	0.71	Connectivity	4.72	-0.59	0.26	0.12
6049	Haipuaena	5	3.17	0.88	Connectivity	2.29	-0.88	0.00	
6050	Punalau	3	2.91	1.87	H90	1.03			
6051	Honomanu	8	2.71	2.71	H90	3.17	0.71	3.17	0.71
6052	Nua'ailua	2	0.18	1.42	Connectivity	-1.24	-1.42	0.18	
6053	Pi`ina`au	14	9.05	0.00	Full	0.00	0.00		
	Palauhulu	14	7.11	0.00	Full	0.00	0.00		
6054	Ohia	1	3.04	0.00	None	3.04			
6055	Waiokamilo	18	2.52	0.00	Full	0.00	0.00		
6056	Wailuanui	8	3.94	0.00	Full	0.00	0.00	2.45	0.71

6057	West Wailuaiki	1	3.88	0.00	Full	0.00		5.75	1.81
6047	Waikamoi	11	4.33	2.46	H90	1.87	-2.44	0.08	0.01
6058	East Wailuaiki	1	3.75	2.39	H90	1.36	-0.58	4.97	1.81
6059	Kopiliula	2	3.23	2.07	H90	1.16	-0.52	4.26	1.55
	Puakaa		0.71	0.13	Connectivity	0.58	-0.13		
6060	Waiohue	3	3.23	0.00	Full	0.00	0.00	3.36	1.87
6061	Paakea	2	0.58	0.12	Connectivity	0.47	-0.12	0.58	
6062	Waiaaka	1	0.50	0.50	None	0.00	-0.15	0.52	0.35
6063	Kapaula	2	1.81	0.36	Connectivity	1.45	1.12	2.80	1.49
6064	Hanawi	6	2.97	0.59	Connectivity	2.38	1.08	4.01	1.68
6065	Makapipi	3	0.84	0.00	Full	0.00	0.00	0.84	
TOTAL: Wailoa Ditch				**16.22**		**20.35**	**2.21**	**43.81**	**14.46**
Streams West of Honopou to Maliko						8.00			
Brackish (pro-rated based on total irrigation						17.84			
HC&S TOTAL						**46.19**			

LIST OF TABLES AND FIGURES